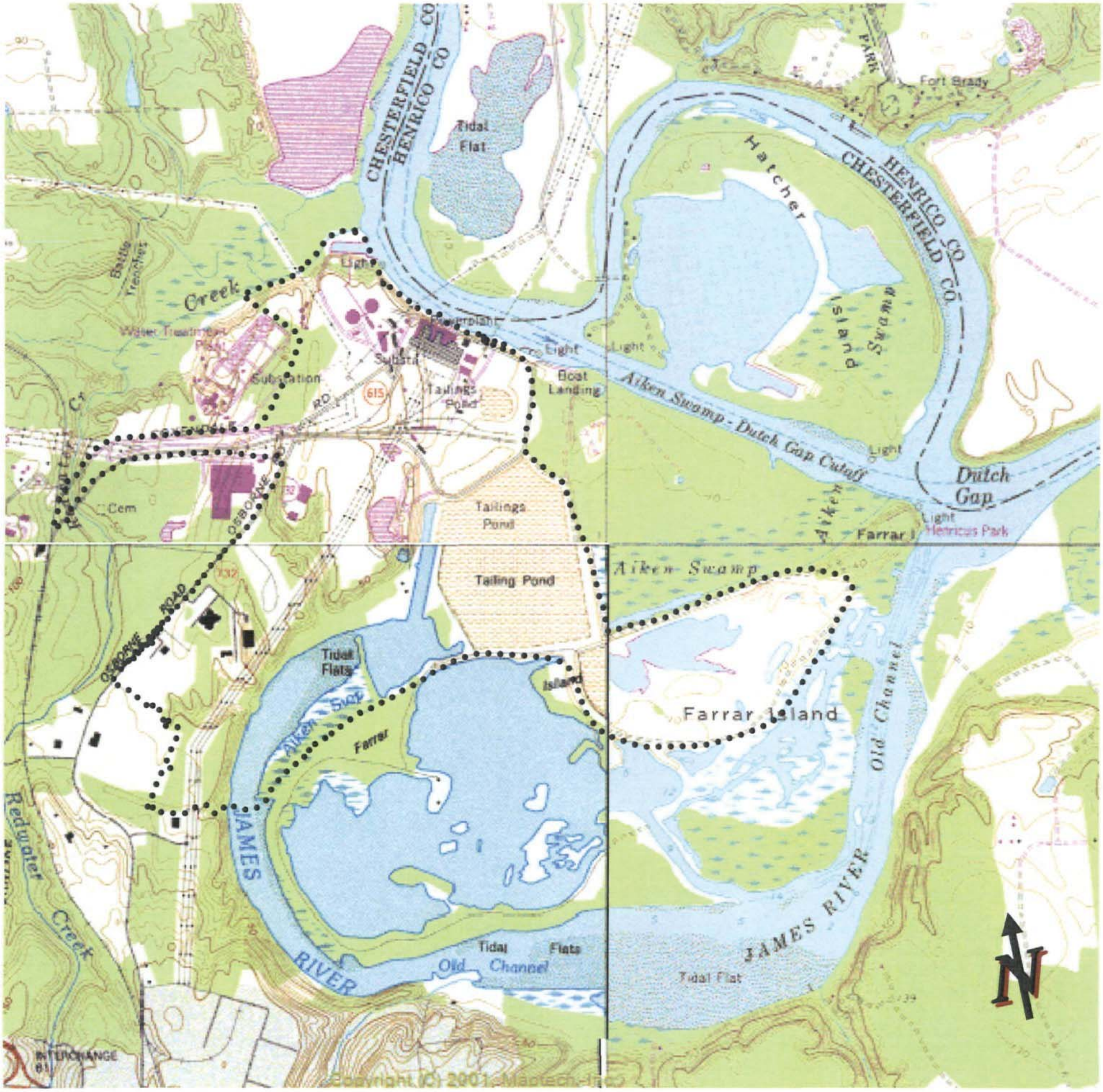
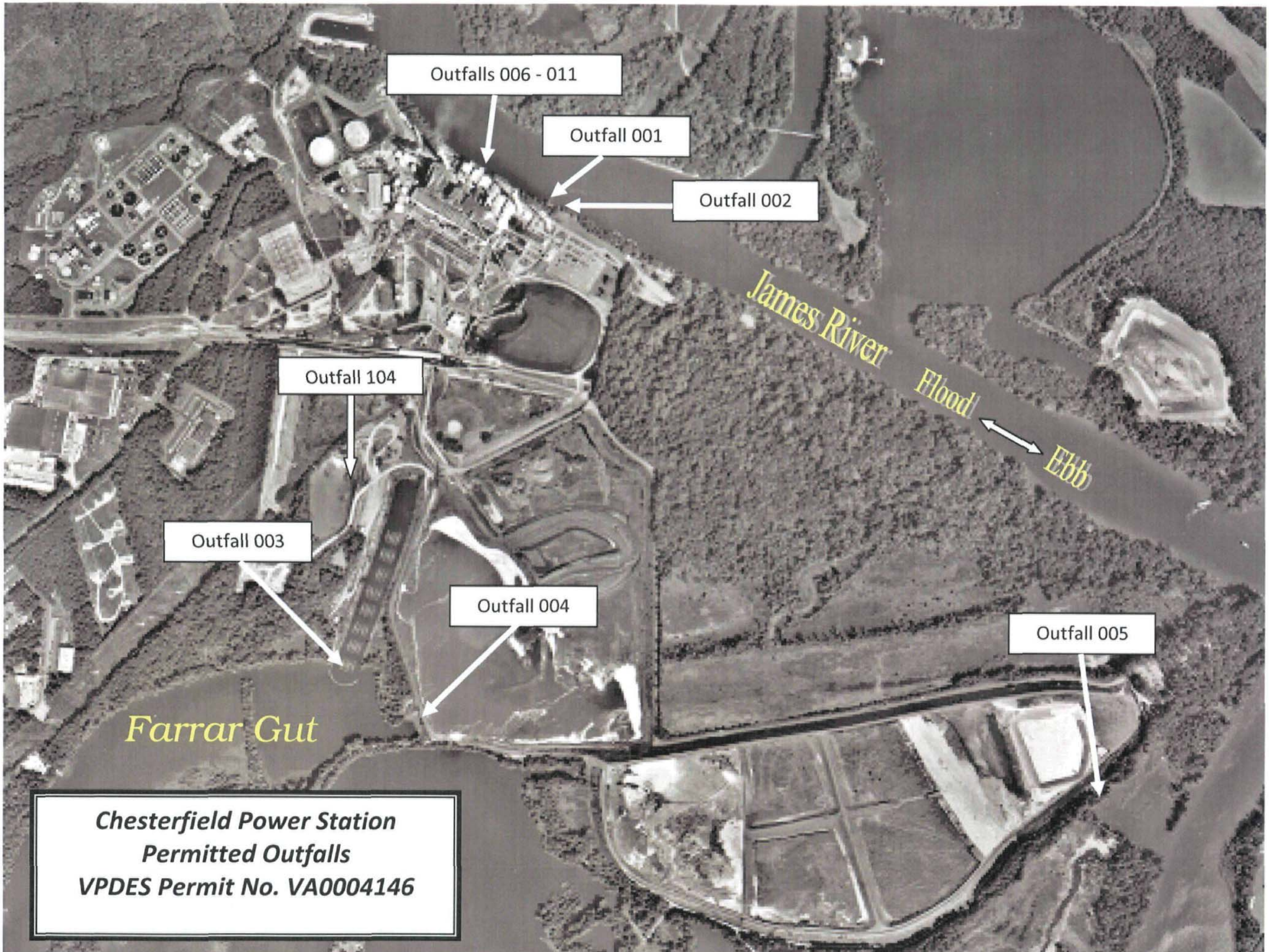
**Attachment 1**

Location and Site Maps

## Chesterfield Power Station
## Topographic Map Showing Approximate Property Boundary



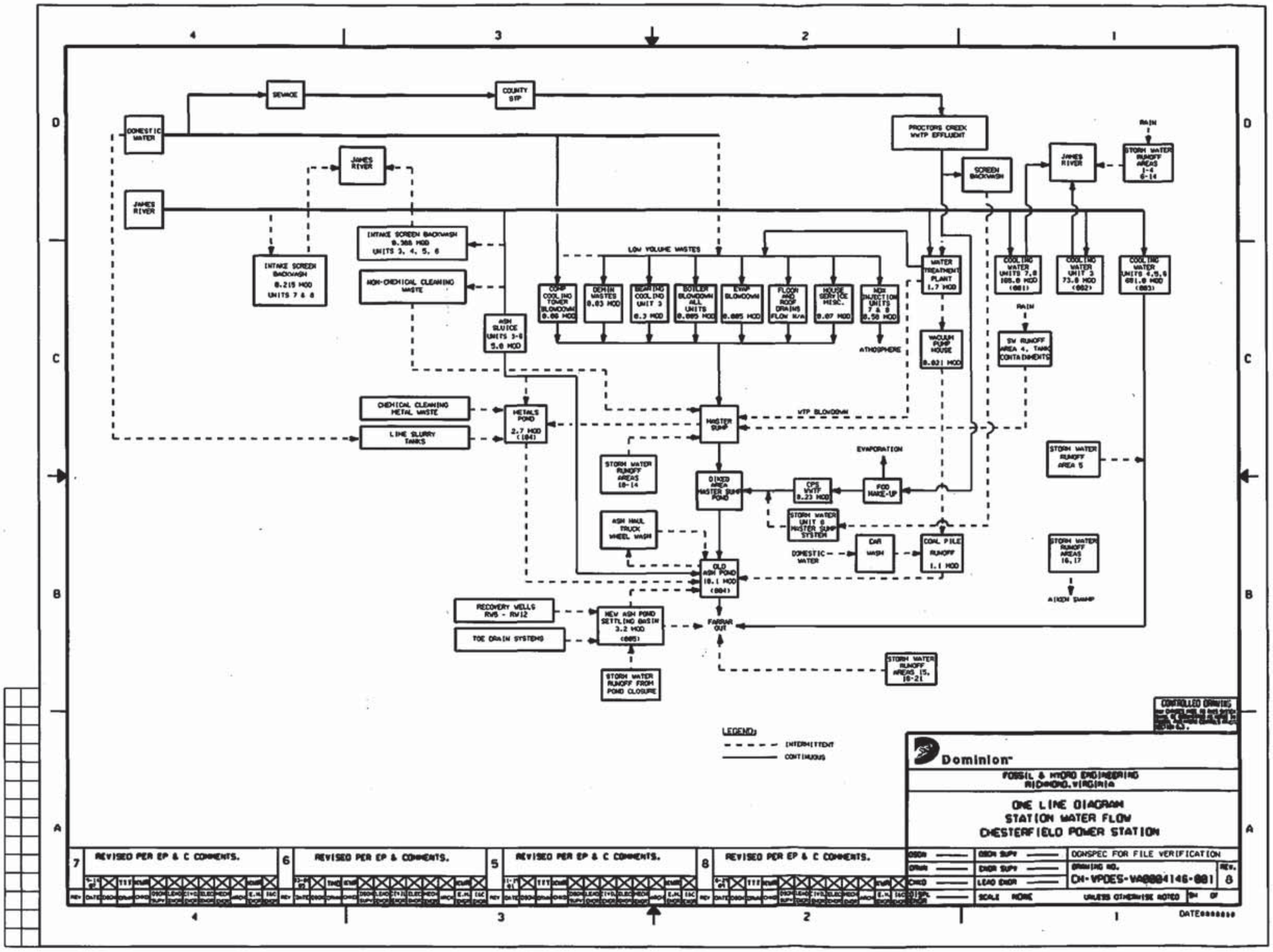

**USGS Drewrys Bluff (VA) Quadrangle**
**1" = 0.4 miles**
**Approximate Property Boundary**
**................................**



Outfalls 006 - 011
Outfall 001
Outfall 002
James River
Flood
Ebb
Outfall 104
Outfall 003
Outfall 004
Outfall 005
Farrar Gut
Chesterfield Power Station
Permitted Outfalls
VPDES Permit No. VA0004146

**Attachment 2**

Water Flow Diagram and Narrative & List of Chemicals Present and Map of Storage.



DOMESTIC WATER
SEWAGE
COUNTY STP
PROCTORS CREEK WWTP EFFLUENT
JAMES RIVER
SCREEN BACKWASH
STORM WATER RUNOFF AREAS 1-4 6-14
RAIN
INTAKE SCREEN BACKWASH 0.215 MGD UNITS 7 & 8
INTAKE SCREEN BACKWASH 0.368 MGD UNITS 3, 4, 5, 6
NON-CHEMICAL CLEANING WASTE
LOW VOLUME WASTES
ASH SLUICE UNITS 3-6 5.0 MGD
COMP COOLING TOWER BLOWDOWN 0.08 MGD
DEMIN WASTES 0.03 MGD
BEARING COOLING UNIT 3 0.3 MGD
BOILER BLOWDOWN ALL UNITS 0.005 MGD
EVAP BLOWDOWN 0.005 MGD
FLOOR AND ROOF DRAINS FLOW N/A
HOUSE SERVICE MISC. 0.07 MGD
NOX INJECTION UNITS 7 & 8 0.58 MGD
ATMOSPHERE
WATER TREATMENT PLANT 1.7 MGD
VACUUM PUMP HOUSE 0.021 MGD
COOLING WATER UNITS 7,8 105.0 MGD (001)
COOLING WATER UNIT 3 73.0 MGD (002)
COOLING WATER UNITS 4,5,6 081.0 MGD (003)
SW RUNOFF AREA 4, TANK CONTAINMENTS
CHEMICAL CLEANING METAL WASTE
LIME SLURRY TANKS
METALS POND 2.7 MGD (104)
MASTER SUMP
WTP BLOWDOWN
STORM WATER RUNOFF AREAS 10-14
STORM WATER RUNOFF AREA 5
DIKED AREA MASTER SUMP POND
CPS WWTP 0.23 MGD
FGD MAKE-UP
EVAPORATION
STORM WATER UNIT 8 MASTER SUMP SYSTEM
ASH HAUL TRUCK WHEEL WASH
DOMESTIC WATER
CAR WASH
COAL PILE RUNOFF 1.1 MGD
STORM WATER RUNOFF AREAS 16,17
AIKEN SWAMP
OLD ASH POND 10.1 MGD (004)
RECOVERY WELLS RW5 - RW12
TOE DRAIN SYSTEMS
NEW ASH POND SETTLING BASIN 3.2 MGD (005)
FARRAR GUT
STORM WATER RUNOFF AREAS 15, 18-21
STORM WATER RUNOFF FROM POND CLOSURE
LEGEND:
INTERMITTENT
CONTINUOUS
CONTROLLED DRAWING
Dominion
FOSSIL & HYDRO ENGINEERING RICHMOND, VIRGINIA
ONE LINE DIAGRAM
STATION WATER FLOW
CHESTERFIELD POWER STATION
DOMSPEC FOR FILE VERIFICATION
DRAWING NO.
CH-VPDES-VA0004146-001
REV. 8
SCALE NONE
UNLESS OTHERWISE NOTED
7 REVISED PER EP & C COMMENTS.
6 REVISED PER EP & C COMMENTS.
5 REVISED PER EP & C COMMENTS.
8 REVISED PER EP & C COMMENTS.

# FORM 2C - NPDES

## Item II-A: LINE DRAWING

### Steam and Evaporative Losses

A precise water balance cannot be provided as a considerable amount of water is released to the atmosphere as steam or evaporation, and we do not have estimates or measurements of these water losses, which can vary greatly with season and station operating conditions. The dashed lines on the drawing represent flows that occur on an intermittent basis. Rainfall runoff contributing to average flows of internal discharges is not available for several sources or treatment units.

### Industrial Storm Water Discharges

Industrial storm water discharges from the station to the James River, Farrar Gut, and Aiken Swamp are identified for informational purposes only. These discharges are permitted under the VPDES General Storm Water Permit VAR540079.

## Item II-B: WASTEWATER SOURCES TO EACH OUTFALL

### Non-Process Water Discharges

There is no discharge of process water from the following points:

- Intake screen backwash
- Occasional pumping of river water from intake screen wells to permit access for maintenance
- Discharges associated with the routine testing of the fire fighting system involving the withdrawal and direct return of water from the river
- The discharge from one sump pump each in the condenser cooling water intake pump rooms for Units 7 and 8.

### OUTFALL 004: Lower (Old ) Ash Pond

The Old (Lower) Ash Pond is located across Coxendale Road south of the Chesterfield Power Generation Facility. Fly ash, bottom ash, and pyrites produced by generating units 3, 4, 5, and 6 are sluiced to the head of the ash pond using water withdrawn from the circulating river water system. The ash sluicing system typically operates 24 hours per day and alternates between bottom ash or fly ash as needed with the flow rate dependant on which generating units are on line. Wastewater treatment in the Lower Ash Pond consists primarily of settling, and chemical coagulants may be added from time to time to facilitate this process. Chemicals may also be added as needed for pH adjustment to ensure that the discharge pH is within the allowable range. Ash that settles within the ash pond is manually removed and is transported via truck to the New Ash Pond where it is used in the pond closure project. Bottom ash sluice may be directed to a processing area where a portion of the bottom ash is removed for beneficial reuse.

In addition to ash sluice water, the Old Ash Pond also receives most of the station's low volume wastes, non-chemical cleaning wastes, chemical cleaning wastes (via the metals pond), and coal pile runoff. The ash pond also receives effluent from the FGD chloride purge stream wastewater treatment plant, screen backwash associated with the reuse of Proctors Creek WWTP effluent, wastewater from the station's car wash (non-chemical), and storm water from the Unit 6 FGD runoff collection system, from a portion of Drainage Area 4 (includes demineralizer building and associated ASTs), and from various other onsite tank containment areas including the station's light oil storage tank.

Metals Cleaning Waste Treatment Basin or Metals Pond (Outfall 104)

The influent flows to the metals cleaning waste treatment basin (Outfall 104) consist of chemical cleaning wastes from periodic cleanings of the station's boilers, and non-chemical wastewater from precipitator and air preheater washes. Non-chemical cleaning wastewater from exterior boiler washes is typically routed directly to the ash pond via the master sump. The volume of wastewater generated by individual chemical and non-chemical washings is not measured. These wastewaters are generated infrequently, and the volume of water generated during a particular washing event is dependent on the amount, type and condition of the equipment being cleaned.

Flue Gas Desulphurization Chloride Purge Stream Wastewater Treatment Plant and Associated Storm Water Runoff

Flue gas desulphurization (FGD) is the current state-of-the art technology used for removing sulfur dioxide ($SO_2$) from the exhaust flue gases from steam electric power plants that burn coal or oil. Dominion is installing FGD technology at CPS to reduce $SO_2$ emissions from four pulverized coal-fired generating units 3, 4, 5, and 6. Installation of the FGD technology associated with Unit 6 was completed, and the unit became operational, during 2008. A second FGD is currently being constructed to handle the combined $SO_2$ emissions from Units 3, 4, and 5. The scrubber tie-ins to the second FGD unit are scheduled to begin during the spring 2011 and should be completed by spring 2012.

The FGD technology being installed and operated at CPS involves a wet scrubbing system where pulverized limestone is blended with water to form a slurry. The slurry is then sprayed into the exhaust flue gas and the calcium carbonate ($CaCO_3$) in the slurry reacts with the $SO_2$ in the flue gas to form calcium sulfate ($CaSO_4$) or gypsum. The resulting gypsum is collected, and then dewatered using two stages of hydro-cyclones followed by vacuum filtration to separate and reclaim the gypsum. The remaining water is returned for reuse in the scrubber.

The primary source of make-up water to the FGD units is final effluent from the Proctors Creek Wastewater Treatment Plant (WWTP). Wastewater from the Proctors Creek WWTP is discharged to the James River through two pipes, which run along a Chesterfield County easement through Dominion property just west of the station's barge slip. The wastewater for reuse at CPS is diverted from the two discharge pipes via a pumping station located on Dominion property adjacent to the County's discharge pipes. James River water will serve as a back-up water source to the FGD.

Each FGD unit requires approximately 1,400 gpm (2.016 mgd) of make-up water. The great majority of the make-up water to each FGD will be lost to the atmosphere through evaporation. Dominion may also use about 2,000 gpm (2.88 mgd) of additional Proctors Creek effluent as make-up water to many other plant processes that are currently supplied by water withdrawn from the James River.

Dominion plans to reclaim gypsum that is suitable for use in the manufacture of commercial wallboard. To produce wallboard-quality gypsum requires the use of a high purity limestone in conjunction with a gypsum reclamation process designed to maintain a chloride concentration of less than 30,000 mg/L in the circulating FGD water system. Maintenance of the appropriate chloride concentration will be accomplished through use of a blowdown (or purge) stream. Each FGD unit will generate approximately 0.115 mgd of CPS that will be directed to the stations FGD wastewater treatment facility (WWTF) located south of the Unit 6 FGD and just southeast of the station's existing fuel oil storage tank. The treated wastewater will then be directed to a master sump, and from there will be pumped to the existing lower ash pond and will eventually be discharged to Farrar Gut through the existing Outfall 004.

Limestone for use in the FGD units is delivered to the station by barge. The limestone is unloaded at the stations existing barge slip and is transferred via conveyor to a covered storage area located just northwest of the station's existing fuel oil storage tank. Reclaimed gypsum is stored in a covered area located just south of the barge slip unloading area and is then loaded onto barges for delivery to a wallboard manufacturer. Reclaimed gypsum may also be placed, along with other coal combustion by-products, in the New (Upper) Ash Pond closure project at CPS. A reserve gypsum storage area is located adjacent to the barge slip just north of the primary gypsum storage area.

Storm water runoff from the Unit 6 FGD site, including the limestone and gypsum storage areas and barge slip collection sump, is collected in 3 yard sumps where it is commingled with effluent from the FGD WWTP, routed to the head of the existing ash pond, and eventually discharged to Farrar Gut via Outfall 004.

The wastewater treatment and storm water management facilities associated with the installation of FGD technology at CPS were described in detail in a Concept Engineering Report that was submitted to DEQ by letter dated October 23, 2007. The CER was was approved by DEQ staff by letter dated March 5, 2008.

Proctors Creek Wastewater Reuse Screen Backwash

There has been some growth of algae on the discharge structure associated with the Proctors Creek WWTP and also within Dominion's sump that receives the WWTP effluent. Periodically, this algae sloughs off and clogs the strainers that are located downstream from the sump but prior to the FGD process. Historically, the station has removed the material from the screens by hand (~ 1/2 of 55 gallon drum per week) but now has plans to install self cleaning screens, which would use a backwash stream of about 180 gpm for 3 minutes a cycle at about 5 cycles per hour (~65,000 gpd). This backwash stream will be routed to the #1 sump associated with the FGD storm water management system, and will ultimately be discharged to Farrar Gut through Outfall 004.

**New Ash Pond Settling Basin (Outfall 005)**

The new ash pond (sometimes referred to as the upper or east ash pond) is being closed. Closure of the pond will be accomplished as described in the revised Ash Pond Closure Plan (September 2003), Phasing Plan (May 2003), and Construction Quality Assurance Plan (May 2003), which were approved by DEQ in a letter dated September 12, 2003. As the site is closed surface runoff is being channeled to a sedimentation basin located at the eastern end of the ash pond. This basin discharges through Outfall 005 to Farrar Gut. The retention time of the basin varies depending on the amount of rainfall that is received during a given period of time. Solids that accumulate in the basin are removed as needed and are returned to the active cells associated with the ash pond closure. During certain periods of the year (primarily summer) the respiration of algae growing in the New Ash Pond Settling Basin (NAPSB) can result in pond pH values that are outside of the acceptable range for discharge through Outfall 005. Should such conditions occur during periods when the NAPSB is full and excessive rains are expected the station may transfer water from the NAPSB to the Lower Ash Pond where it is ultimately discharged through Outfall 004

In addition to surface runoff, the sedimentation pond also receives ground water collected in four (4) "toe drains", and from recovery wells located along Henricus Road to the east of the basin. The recovery wells were installed during 1996 along the northern crest of the Upper (New) Ash Pond dike. The recovery wells were installed to counter excess pressures and seepage forces resulting from increased water levels in the new ash pond that occurred during periods when ash was being dredged from the lower ash pond to the upper ash pond. The wells are equipped with submersible pumps and collected water is pumped to the pond associated with Outfall 005. With dredging and sluicing wet ash no longer occurring and water levels well below former trigger levels, these wells are no longer necessary to maintain stability of the north dike.

**Intake Screen Backwash Discharges (Outfalls 006 – 011)**

The cooling water intake structures at the Chesterfield Power Station are equipped with trash bars, vertical traveling screens, and an intake screen backwash system (ISBS). Collectively the ISBS consists of thirteen individual backwash flows (designated as Outfalls 006 – 011 in the current VPDES permit) to the main channel of the James River. Operation of the ISBS is on an "as needed" basis with the frequency of operation dependent on the amount of debris that is present in the river. Typically spring (March and April) and fall (October and November) are the periods of highest ISBS operation. During other periods of the year the ISBS is operated approximately two hours per day.

The intake screen wash water for all units is James River water that is taken from the station's circulating water system before contact with industrial processes. Historically, chlorine was added to the circulating water system at points prior to removal of the water for use in the ISBS. As a result, monitoring data indicated that some residual chlorine was present in the ISBS discharges and, consequently, water quality-based effluent limits for total residual chlorine (TRC) were included on Outfalls 006 – 011 when the permit was reissued effective December 10, 2004. Also included in the permit was a four-year schedule requiring compliance with the TRC limits by December 10, 2008.

By letter dated June 8, 2006, Dominion submitted to DEQ our Plan of Action and Conceptual Engineering Report for achieving compliance with the TRC limits. The compliance method selected was to relocate the points for chlorine injection to locations downstream from where the water is withdrawn for use in the ISBS. The compliance plan was approved by DEQ on June 23, 2006, and Dominion began implementation of the plan in August 2006. Relocation of all chlorine injection points was officially completed during the fall of 2008 and there is no longer a station source of chlorine to the screen backwash discharges. Consequently, all ISBS discharges now consist of James River water that has not been contaminated by use in any plant processes, and DEQ staff have indicated that these outfalls will be removed from the permit during the upcoming reissuance process.

## ITEM II-C: INTERMITTENT AND/OR SEASONAL DISCHARGES

**Outfall 005 (New Ash Pond)**

The runoff pond associated with Outfall 005 is typically discharged only during two or three months out of the year, and the duration of each discharge is usually less than 4 days.

**Outfall 104 (Metals Cleaning Waste Treatment Basin)**

The Metals Cleaning Waste Treatment Basin is a batch operated system, which is designed for non-seasonal, intermittent use. Operations that contribute flows to the basin are shown on the line drawings and as described in the narrative under Item 2A above. Typically, the valve is opened to begin the discharge and is not closed again until the pond is drained. During a typical discharge approximately 20 million gallons is released from the pond over a period of about 10 days. The pond level at the start of a discharge is not consistent from discharge to discharge, and, therefore, the total volume discharged from the metals pond during any single discharge event can vary substantially depending on the volume present in the pond prior to discharge.

### Intake Screen Backwash System

The Intake Screen Backwash System is designed to discharge seven days per week and twelve months per year. In practice, however, the system does not operate continuously and individual backwash flows are highly variable. Based on flow estimates determined for the individual unit backwash systems, the collective long-term average (assuming all units operated for 2 hours per day) and daily maximum (assumes all units operated continuously for a 24-hour period) flow rates for the system are 0.60 MGD and 7.24 MGD, respectively. The corresponding long-term average and maximum daily discharge volumes are 0.60 MG and 7.24 MG, respectively.

## ITEM IV-A: IMPROVEMENTS

### Installation of Flue Gas Desulphurization Technology

Flue Gas Desulphurization technology is being installed at the Chesterfield Power Station. See discussion under Item II-B for description of potential impacts.

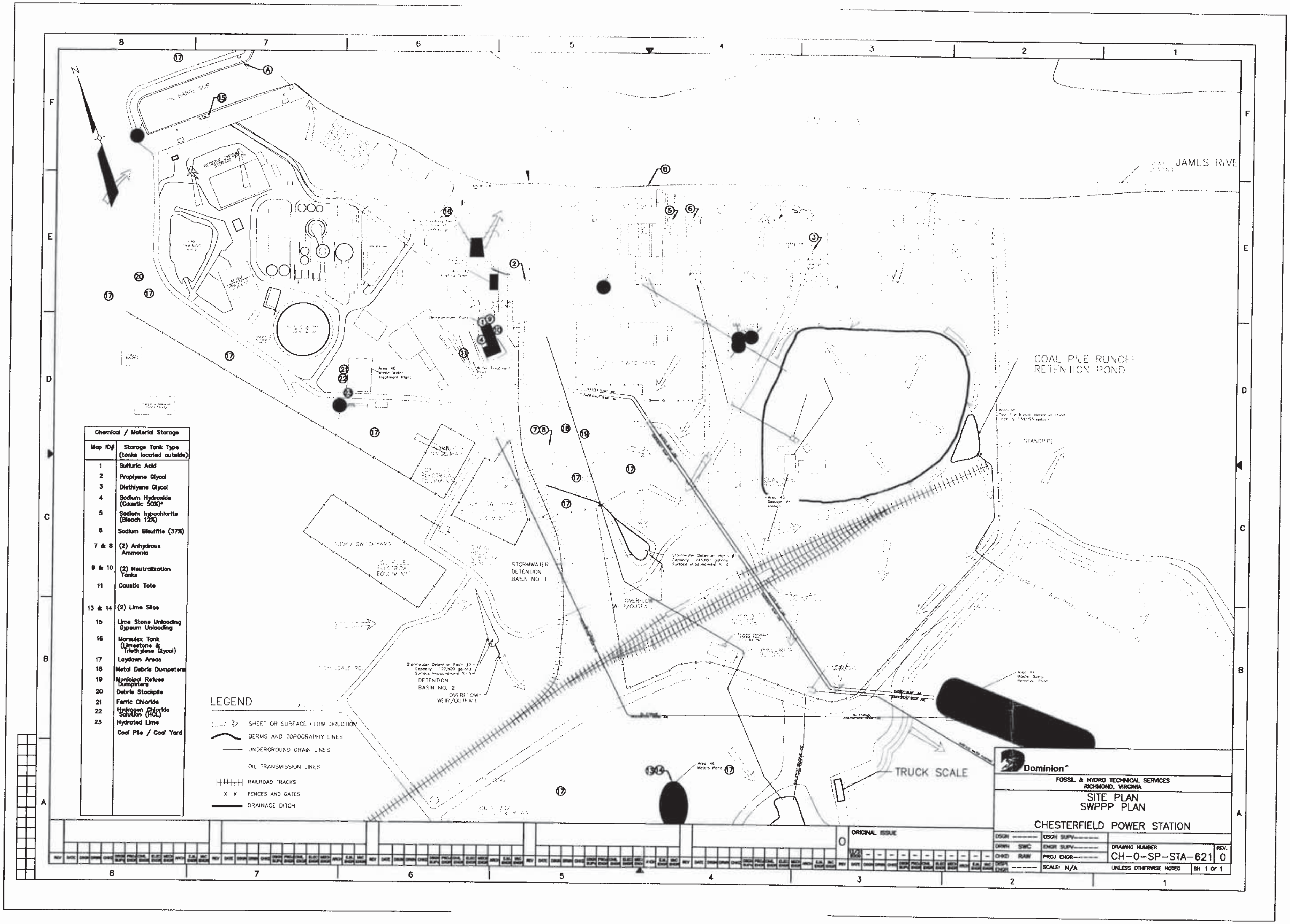
| FORM 2C ITEM V-D | | |
|---|---|---|
| **Chemical** | **Approximate Usage / Year** | **Purpose of Usage** |
| Carbon Dioxide | ~10 tons | Fire suppression systems and generator degassing |
| Propylene Glycol | Constant Use Makeup Only | Antifreeze in heat transfer systems for natural gas and unit combustion air. |
| Ethylene Glycol | Constant Use Makeup Only | Antifreeze in vehicles and equipment. |
| Diethylene Glycol/ Triethylene Glycol | Varies | Antifreeze in vehicles and equipment and freeze conditioning of coal. Grinding agent for Marsulex limestone. |
| Unleaded Gasoline | Varies | Fuel |
| Calcium Hydroxide Hydrated Lime | ~408 tons | pH adjustment in settling ponds and FGD WWTP |
| BetzDearborn KlarAid PC 1195 (coagulant) | Varies | Settling aid (ash pond) |
| Unleaded Gasoline | Varies | Fuel |
| Diesel Fuel | Varies | Fuel |
| Sulfuric Acid | ~478 tons | Regenerate chemical for demineralizer system |
| Sodium Hydroxide (Caustic 50%) | ~923 tons | Regenerate chemical for demineralizer system |
| Sodium Hydroxide 25% | ~108 tons | pH control in water plant |
| Sodium Chloride | ~550 tons | Water treatment for softener regeneration |
| Sodium Hypochlorite (Bleach 12%) | ~200 tons | Condenser cooling water chlorination, various sanitation activities |
| Sodium Bisulfite (37%) | ~1,000 tons | De-chlorination of condenser cooling water/RO influent |
| Methoxypropylamine | ~8 tons | Corrosion control in plant condensate system |
| Carbohydrazide | ~8 tons | Corrosion control in plant condensate and boiler systems (reducing agent) |
| Trisodium Phosphate | ~10 tons | Corrosion control in plant boilers |
| Anhydrous Ammonia | 4,000 tons | SCR use |
| TMT 15 | ~21 tons | Heavy metal removal, Waste Water Treatment Plant |
| Hydrochloric Acid | ~40 tons | pH control, Waste Water Treatment Plant, Boiler Chemical Cleaning. |
| Ferric Chloride | ~41 tons | Coagulant, Waste Water Treatment Plant |
| Dibasic Acid &/or Formic Acid | Varies | Limestone slurry aid, Waste Water Treatment Plant |
| Nalco 7768 | Varies-+ | Floculant, Waste Water Treatment Plant |
| Wastewater sludge | 14 tons (varies) | Transported off site |
| Limestone | 46,834 tons | Scrubber absorber & Marsulex system |
| Gypsum | 65,948 tons | Scrubber commercial product |

| FORM 2C ITEM V-D | | |
|---|---|---|
| **Chemical** | **Approximate Usage / Year** | **Purpose of Usage** |
| Xylene | As needed | Paint ingredient only (not allowed as stand alone solvent) |
| Methyl Ethyl Ketone | N/A | Paint solvent (not allowed on site as stand-alone solvent) |
| Ammonium EDTA | Varies | Boiler cleaning |
| Aqueous Ammonia | Varies | Boiler cleaning |
| Thiourea | Varies | Boiler cleaning (copper complexor) |
| Ammonium Carbonate | N/A | Chemical cleaning of plant equipment |
| Sodium Nitrite | N/A | Chemical cleaning of plant equipment |
| Ammonium Bicarbonate | N/A | Chemical cleaning of plant equipment |
| Citric Acid | N/A | Chemical cleaning of plant equipment |
| Sodium Bromate | N/A | Chemical cleaning of plant equipment |
| Ammonium Bifluoride | N/A | Chemical cleaning of plant equipment |
| Wen Don CL89 | Varies | General cleaning of various station equipment |
| Detergents / cleaning agents | Varies | General cleaning of various station equipment |
| Soda Ash (Sodium Carbonate) | Varies | General and chemical cleaning pH control |
| Denatured Alcohol | As needed | Various maintenance activities |
| Natural Gas Condensate | < 200 gals | Byproduct collected from use of Natural Gas |
| Tri-aryl Phosphate | N/A | Hydraulic fluid for turbine operation control |
| Mercury | N/A | Mercoid switches, thermometers, etc. |
| Nalco 3D Trasar 3DT189 aromatic amine | 655 pounds | Cooling Tower treatment |
| Nalco 7330 | varies | Cooling Tower treatment |
| Nalco Towerbrom991 | 225 pounds | Cooling Tower micro biocide |
| Nalco 8325 | 55 gallons | Cooling Tower treatment corrosion inhibitor |
| Mineral Oil | Varies | Equipment lubrication |
| Mineral Oil | Varies | Equipment lubrication |

## ITEM VI: USE OR MANUFACTURE OF A TOXIC POLLUTANT AS AN INTERMEDIATE OR FINAL PRODUCT OR BYPRODUCT

The following pollutants listed in ITEM V-C may be present in coal and/or coal combustion by-products:

| | | |
|---|---|---|
| Total Antimony | Total Copper | Total Silver |
| Total Arsenic | Total Lead | Total Thallium |
| Total Beryllium | Total Mercury | Total Zinc |
| Total Cadmium | Total Nickel | Total Cyanide |
| Total Chromium | Total Selenium | Total Phenols |




| Chemical / Material Storage | |
|---|---|
| Map ID# | Storage Tank Type (tanks located outside) |
| 1 | Sulfuric Acid |
| 2 | Propylene Glycol |
| 3 | Diethylene Glycol |
| 4 | Sodium Hydroxide (Caustic 50%)* |
| 5 | Sodium hypochlorite (Bleach 12%) |
| 6 | Sodium Bisulfite (37%) |
| 7 & 8 | (2) Anhydrous Ammonia |
| 9 & 10 | (2) Neutralization Tanks |
| 11 | Caustic Tote |
| 13 & 14 | (2) Lime Silos |
| 15 | Lime Stone Unloading Gypsum Unloading |
| 16 | Marsulex Tank (Limestone & Triethylene Glycol) |
| 17 | Laydown Areas |
| 18 | Metal Debris Dumpsters |
| 19 | Municipal Refuse Dumpsters |
| 20 | Debris Stockpile |
| 21 | Ferric Chloride |
| 22 | Hydrogen Chloride Solution (HCL) |
| 23 | Hydrated Lime |
| | Coal Pile / Coal Yard |

**Attachment 3**

Ambient Stream Characterization

# MEMORANDUM

**DEPARTMENT OF ENVIRONMENTAL QUALITY**
**Piedmont Regional Office**
**4949-A Cox Road Glen Allen, Virginia 23060**

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**SUBJECT:** Flow Frequency Determination / 303(d) Status
Dominion Virginia Power's Chesterfield Power Station – VA0004146

**TO:** Emilee Carpenter

**FROM:** Jennifer Palmore, P.G.

**DATE:** November 4, 2011

**COPIES:** File

The Dominion Virginia Power's Chesterfield Power Station is located in Dutch Gap, Virginia. The facility discharges via 11 outfalls to the James River and Farrar Gut, which is an old channel of the James River. Stream flow frequencies and the current 303(d) status have been requested for use in developing effluent limitations for the VPDES permit.

At the discharge, the James River is tidally influenced. Flow frequencies cannot be determined for tidal waters and tidal mix ratios should be used for outfalls 001, 002, and 006-011. Farrar Gut is also tidal; however, the gut is dominated by the discharge from the power station's outfall 003, which is the condenser cooling water from units 4, 5, & 6. The effluent flow from outfall 003 should be used for analysis for outfalls 003, 004, and 005.

During the 2010 305(b)/303(d) Water Quality Integrated Report, the receiving streams were assessed as Category 5A waters ("A Water Quality Standard is not attained. The water is impaired or threatened for one or more designated uses by a pollutant(s) and requires a TMDL (303d list)."). The applicable fact sheets are attached. In the James River, the Recreation Use is impaired due to E. coli violations, the Fish Consumption Use is impaired due to a VDH Fish Consumption Advisory for PCBs, and the Aquatic Life Use was impaired due to violation of the chlorophyll a standard as well as inadequate submerged aquatic vegetation (SAV) and low dissolved oxygen in the upper James River tidal freshwater estuary. In addition, there were screening level exceedances for mercury and arsenic in fish tissue and the area is included in the VDH Fish Consumption Advisory for kepone; these are considered non-impairing "observed effects". The Public Water Supply and Wildlife Uses were fully supporting.

Farrar Gut was also impaired of the Aquatic Life Use due to the SAV and dissolved oxygen impairment in the estuary. The Fish Consumption Use is considered fully supporting with observed effects due to the kepone advisory. There was insufficient information to assess the Recreation Use; however E.coli was considered a non-impairing observed effect. The Wildlife Use was not assessed.

The James River and Tributaries -City of Richmond Bacterial TMDL was approved by the EPA on 11/4/2010. The power station was included in the TMDL; however, the facility was not assigned a bacteria wasteload allocation because it is not permitted for fecal coliform control.

The Chesapeake Bay TMDL was approved by the EPA on 12/29/2010. The TMDL addresses SAV, dissolved oxygen, and chlorophyll a impairments in tidal waters throughout the Chesapeake Bay. Dominion Virginia Power Chesterfield was included in the aggregated total nitrogen, total phosphorus, and total suspended solids (TSS) allocations for significant wastewater facilities in the upper James River tidal freshwater estuary segment (JMSTF2). The Watershed Implementation Plan states that the nutrient allocations will be addressed through the Nutrient Watershed General Permit and that technology-based limits for TSS should be included in individual VPDES permits.

The James River and Farrar Gut are considered Tier 1 waters because the Richmond-Crater Water Quality Management Plan allows the dissolved oxygen in the river to drop to 5.0 mg/L.

Water quality data from monitoring station 2-JMS099.30 is attached. The station is a long-term monitoring station located at Buoy 157, approximately 4 miles upstream of Farrar Gut. The data from this station represent background ambient (pre-mix) conditions before interaction with the heated effluent from the facility.

As the Water Quality Standards designate this area as tidal freshwater, the freshwater Aquatic Life criteria should be applied.

If you have any questions concerning this analysis or need additional information, please let me know.

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 7/22/1968 | S | 0.3 | 30 | 7 | | 3.8 | | | |
| 2-JMS099.30 | 9/8/1968 | S | 0.3 | 27.22 | 7 | | 3.9 | | | |
| 2-JMS099.30 | 3/20/1969 | S | 0.3 | 10 | 7.2 | | 8.8 | | | |
| 2-JMS099.30 | 6/19/1969 | S | 0.3 | 25.56 | 6.3 | | 4.7 | | | |
| 2-JMS099.30 | 10/2/1969 | S | 0.3 | 21.11 | 7.3 | | 3.6 | | | |
| 2-JMS099.30 | 4/21/1970 | S | 0.3 | 17.78 | 7.3 | | 6.8 | | | |
| 2-JMS099.30 | 5/5/1970 | S | 0.3 | 20 | 6.9 | | 7.6 | | | |
| 2-JMS099.30 | 6/18/1970 | S | 0.3 | 28.33 | 6.8 | | 4.4 | | | |
| 2-JMS099.30 | 7/2/1970 | S | 0.3 | 28.89 | | | 3.8 | | | |
| 2-JMS099.30 | 7/22/1970 | S | 0.3 | 27.78 | 7.2 | | 1.6 | | | |
| 2-JMS099.30 | 8/15/1970 | S | 0.3 | 31.11 | 7.3 | | 3.6 | | | |
| 2-JMS099.30 | 8/26/1970 | S | 0.3 | 28.89 | 6.9 | | 3.2 | | | |
| 2-JMS099.30 | 9/9/1970 | S | 0.3 | 29.44 | | | 4.2 | | | |
| 2-JMS099.30 | 5/6/1971 | S | 0.3 | 17.22 | 7.3 | | 6.2 | | | |
| 2-JMS099.30 | 6/13/1971 | S | 0.3 | 23.33 | 7.3 | | 6 | | | |
| 2-JMS099.30 | 7/5/1971 | S | 0.3 | 28.89 | 8.6 | | 8.2 | | | |
| 2-JMS099.30 | 7/23/1971 | S | 0.3 | 28.33 | 7.5 | | 4 | | | |
| 2-JMS099.30 | 8/3/1971 | S | 0.3 | 29.44 | 7.3 | | 5 | | | |
| 2-JMS099.30 | 8/31/1971 | S | 0.3 | 26.11 | 6.7 | | 6.4 | | | |
| 2-JMS099.30 | 9/26/1971 | S | 0.3 | 23.89 | 7.5 | | 6.4 | | | |
| 2-JMS099.30 | 10/27/1971 | S | 0.3 | 18.89 | 7 | | 9 | | | |
| 2-JMS099.30 | 5/2/1972 | S | 0.3 | 20.56 | 7.3 | | 6 | | | |
| 2-JMS099.30 | 7/8/1972 | S | 0.3 | 21.11 | 7.4 | | 8.4 | | | |
| 2-JMS099.30 | 7/31/1972 | S | 0.3 | 25 | | | 8.4 | | | |
| 2-JMS099.30 | 8/9/1972 | S | 0.3 | 26.67 | 7.7 | | 6.8 | | | |
| 2-JMS099.30 | 8/20/1972 | S | 0.3 | | 7 | | 6 | | | |
| 2-JMS099.30 | 9/5/1972 | S | 0.3 | 25.56 | 7 | | 7.2 | | | |
| 2-JMS099.30 | 10/4/1972 | S | 0.3 | 21.11 | 7.7 | | 7 | | | |
| 2-JMS099.30 | 5/3/1973 | S | 0.3 | 17.78 | 7 | | 8.3 | | | |
| 2-JMS099.30 | 6/6/1973 | S | 0.3 | 26.11 | 7.8 | | 7 | | | |
| 2-JMS099.30 | 6/9/1973 | S | 0.3 | 28.89 | 7.9 | | 11.79 | | | |
| 2-JMS099.30 | 7/15/1973 | S | 0.3 | 28.33 | 7.3 | | 4 | | | |
| 2-JMS099.30 | 9/29/1973 | S | 0.3 | 29.44 | 7 | | 3.6 | | | |
| 2-JMS099.30 | 8/30/1974 | S | 0.3 | 28 | 7.5 | | 7 | | | |
| 2-JMS099.30 | 9/26/1974 | S | 0.3 | 21 | 7.5 | | 7.2 | | | |
| 2-JMS099.30 | 10/25/1974 | S | 0.3 | 15 | 8 | | 11.19 | | | |
| 2-JMS099.30 | 5/1/1975 | S | 0.3 | 17.22 | 7.3 | | 9.1 | | | |
| 2-JMS099.30 | 6/4/1975 | S | 0.3 | | 7.3 | | 7.9 | | | |
| 2-JMS099.30 | 6/24/1975 | S | 0.3 | 28.33 | 8 | | 8 | | | |
| 2-JMS099.30 | 6/30/1975 | S | 0.3 | 26.67 | 7.5 | | 7.8 | | | |
| 2-JMS099.30 | 7/28/1975 | S | 0.3 | 27.78 | 8 | | 7.6 | | | |
| 2-JMS099.30 | 8/13/1975 | S | 0.3 | 27.78 | 7.5 | | 7 | | | |
| 2-JMS099.30 | 8/16/1975 | S | 0.3 | 30 | 7.7 | | 7.8 | | | |
| 2-JMS099.30 | 9/3/1975 | S | 0.3 | 23.89 | 7.4 | | 7.7 | | | |
| 2-JMS099.30 | 10/1/1975 | S | 0.3 | 20 | 7.5 | | 9.2 | | | |
| 2-JMS099.30 | 2/12/1976 | S | 0.3 | 5.56 | 7.5 | | 12.69 | | | |
| 2-JMS099.30 | 3/11/1976 | S | 0.3 | 10 | 7.5 | | 10 | | | |
| 2-JMS099.30 | 5/4/1976 | S | 0.3 | 20 | 7.5 | | 8.4 | | | |
| 2-JMS099.30 | 6/7/1976 | S | 0.3 | 22.22 | 7.2 | | 8.1 | | | |
| 2-JMS099.30 | 5/22/1978 | S | 0.3 | 20 | 8 | | 9 | | | |
| 2-JMS099.30 | 6/15/1978 | S | 0.3 | 25 | 9 | | 4.7 | | | |
| 2-JMS099.30 | 7/11/1978 | S | 0.3 | 8 | 8 | | 6.1 | | | |
| 2-JMS099.30 | 8/3/1978 | S | 0.3 | 5 | 7 | | 5.5 | | | |
| 2-JMS099.30 | 9/25/1978 | S | 0.3 | 26 | 8.5 | | 7.1 | | | |
| 2-JMS099.30 | 12/12/1978 | S | 0.3 | 8 | 7.5 | | 11.7 | | | |
| 2-JMS099.30 | 4/24/1979 | S | 0.3 | 19 | 7.7 | | 8.7 | | | |
| 2-JMS099.30 | 5/19/1980 | S | 0.3 | 21 | 8.3 | | 8.3 | | | |
| 2-JMS099.30 | 7/16/1980 | S | 0.3 | 28.5 | 8.3 | | 7 | | | |
| 2-JMS099.30 | 10/20/1980 | S | 0.3 | 18 | 8 | | 7.7 | | | |
| 2-JMS099.30 | 7/27/1981 | S | 0.3 | 29 | 8.7 | | 7.8 | | | |
| 2-JMS099.30 | 9/8/1981 | S | 0.3 | 26 | 7.8 | | 7 | | | |
| 2-JMS099.30 | 11/16/1981 | S | 0.3 | 11 | 7.2 | | 6.9 | | | |
| 2-JMS099.30 | 5/13/1982 | S | 0.3 | 21.5 | 8.7 | | 7.2 | | | |
| 2-JMS099.30 | 6/24/1982 | S | 0.3 | 25 | 7.5 | | 7 | | | |
| 2-JMS099.30 | 8/9/1982 | S | 0.3 | 28 | 7.2 | | 5.5 | | | |
| 2-JMS099.30 | 10/28/1982 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 11/18/1982 | S | 0.3 | 9 | 6.9 | | 10.6 | | | |
| 2-JMS099.30 | 5/17/1983 | S | 0.3 | 19.5 | 7.9 | | 8.5 | | | |
| 2-JMS099.30 | 6/28/1983 | S | 0.3 | 28.5 | 7 | | 7.1 | | | 0.5 |
| 2-JMS099.30 | 8/30/1983 | S | 2.74 | | | | | | | |
| 2-JMS099.30 | 8/30/1983 | B | 32.92 | | | | | | | |
| 2-JMS099.30 | 9/20/1983 | S | 0.91 | 26.5 | 7.6 | | 8 | | | 0.2 |
| 2-JMS099.30 | 9/20/1983 | M | 2.74 | | | | | | | |
| 2-JMS099.30 | 9/20/1983 | B | 42.98 | | | | | | | |
| 2-JMS099.30 | 10/3/1983 | S | 0.91 | 20 | 7.8 | | 7.3 | | | 0.3 |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 10/3/1983 | M | 2.74 | | | | | | | |
| 2-JMS099.30 | 10/3/1983 | B | 31.7 | | | | | | | |
| 2-JMS099.30 | 10/12/1983 | S | 0.91 | | | | | | | 0.4 |
| 2-JMS099.30 | 7/12/1984 | S | 1 | 26 | 6.9 | 7.6 | | | | |
| 2-JMS099.30 | 7/31/1984 | S | 11 | 24.5 | | 7.2 | | | 0 | |
| 2-JMS099.30 | 7/31/1984 | S | 1 | 24.5 | 7.3 | 7.3 | | | 0 | 0.8 |
| 2-JMS099.30 | 8/15/1984 | S | 11 | 24 | 6.8 | 8.6 | | | | |
| 2-JMS099.30 | 8/15/1984 | S | 1 | 24 | 7 | 8.6 | | | | 0.2 |
| 2-JMS099.30 | 9/12/1984 | S | 1 | 24 | 7.8 | 7.6 | | | | 0.7 |
| 2-JMS099.30 | 9/12/1984 | B | 11 | 23.5 | 7.7 | 7.2 | | | | |
| 2-JMS099.30 | 9/25/1984 | S | 1 | 23.5 | | 7.1 | | | | 1 |
| 2-JMS099.30 | 9/25/1984 | B | 12 | 23.5 | | 7.4 | | | | |
| 2-JMS099.30 | 10/11/1984 | S | 3 | 19.5 | | 8.3 | | | 0 | |
| 2-JMS099.30 | 10/11/1984 | M | 5 | 19.5 | | 8.3 | | | 0 | |
| 2-JMS099.30 | 10/11/1984 | M | 7 | 19 | | 8.3 | | | 0 | |
| 2-JMS099.30 | 10/11/1984 | M | 9 | 19 | | 8.3 | | | 0 | |
| 2-JMS099.30 | 10/11/1984 | B | 10 | 19 | 6.6 | 8.3 | | | 0 | |
| 2-JMS099.30 | 10/11/1984 | S | 1 | 19.5 | 7 | 8.3 | | | 0 | 0.9 |
| 2-JMS099.30 | 10/18/1984 | S | 1 | 19.5 | 7.2 | 8.5 | | | | 1 |
| 2-JMS099.30 | 10/18/1984 | B | 12 | 19.5 | 7.2 | 8.4 | | | | |
| 2-JMS099.30 | 11/2/1984 | S | 1 | 20.5 | 7.1 | 7.9 | | | 0 | 1.1 |
| 2-JMS099.30 | 11/2/1984 | M | 3 | 20.5 | | 7.8 | | | 0 | |
| 2-JMS099.30 | 11/2/1984 | M | 5 | 20.5 | | 7.8 | | | 0 | |
| 2-JMS099.30 | 11/2/1984 | M | 7 | 20.5 | | 7.8 | | | 0 | |
| 2-JMS099.30 | 11/2/1984 | B | 9 | 20.5 | 6.8 | 7.7 | | | 0 | 1.1 |
| 2-JMS099.30 | 11/16/1984 | S | 1 | 11 | 7.6 | 11 | | | 0 | 1.2 |
| 2-JMS099.30 | 11/16/1984 | M | 3 | 11 | | 11 | | | 0 | |
| 2-JMS099.30 | 11/16/1984 | M | 5 | 11 | | 11 | | | 0 | |
| 2-JMS099.30 | 11/16/1984 | M | 7 | 11 | | 11 | | | 0 | |
| 2-JMS099.30 | 11/16/1984 | M | 9 | 11 | | 11 | | | 0 | |
| 2-JMS099.30 | 11/16/1984 | B | 11 | 11 | 7.5 | 11 | | | 0 | |
| 2-JMS099.30 | 12/12/1984 | S | 1 | 5 | 6.9 | 12 | | | 0.2 | 1 |
| 2-JMS099.30 | 12/12/1984 | M | 3 | 5 | | 12 | | | 0.2 | |
| 2-JMS099.30 | 12/12/1984 | M | 5 | 5 | | 12 | | | 0.2 | |
| 2-JMS099.30 | 12/12/1984 | M | 7 | 5 | | 12 | | | 0.2 | |
| 2-JMS099.30 | 12/12/1984 | B | 9 | 5 | 6.9 | 12.1 | | | 0.2 | |
| 2-JMS099.30 | 2/4/1985 | S | 1 | 1.5 | 6.6 | 14.4 | | | 0 | 0.3 |
| 2-JMS099.30 | 2/4/1985 | M | 3 | 1.5 | | 14.4 | | | 0 | |
| 2-JMS099.30 | 2/4/1985 | M | 5 | 1.5 | | 14.4 | | | 0 | |
| 2-JMS099.30 | 2/4/1985 | M | 7 | 2 | | 14.4 | | | 0 | |
| 2-JMS099.30 | 2/4/1985 | M | 9 | 2 | | 14.4 | | | 0 | |
| 2-JMS099.30 | 2/4/1985 | M | 11 | 2 | | 14.4 | | | 0 | |
| 2-JMS099.30 | 2/4/1985 | B | 13 | 2 | 7 | 14.4 | | | 0 | |
| 2-JMS099.30 | 3/11/1985 | S | 1 | 10 | 6.9 | 11.6 | 11.2 | | | 1.1 |
| 2-JMS099.30 | 3/11/1985 | M | 3 | 10 | | 11.5 | | | 0.1 | |
| 2-JMS099.30 | 3/11/1985 | M | 5 | 10 | | 11.4 | | | 0.1 | |
| 2-JMS099.30 | 3/11/1985 | M | 7 | 10 | | 11.4 | | | 0.1 | |
| 2-JMS099.30 | 3/11/1985 | M | 9 | 10 | | 11.4 | | | 0.1 | |
| 2-JMS099.30 | 3/11/1985 | B | 11 | 10 | 6.8 | 11.3 | 11.1 | | 0.1 | |
| 2-JMS099.30 | 3/27/1985 | S | 1 | 10.5 | 7.4 | 11 | | | 0 | 1.2 |
| 2-JMS099.30 | 3/27/1985 | M | 3 | 10.5 | | 11 | | | 0 | |
| 2-JMS099.30 | 3/27/1985 | M | 5 | 10.5 | | 11 | | | 0 | |
| 2-JMS099.30 | 3/27/1985 | M | 7 | 10.5 | | 10.9 | | | 0 | |
| 2-JMS099.30 | 3/27/1985 | M | 9 | 10.5 | | 10.9 | | | 0 | |
| 2-JMS099.30 | 3/27/1985 | B | 11 | 10.5 | 7.6 | 10.9 | 10.9 | | 0 | |
| 2-JMS099.30 | 4/10/1985 | S | 1 | 12 | 7.5 | 10 | 9.7 | | 0 | 10.2 |
| 2-JMS099.30 | 4/10/1985 | M | 3 | 12 | | 10 | | | 0 | |
| 2-JMS099.30 | 4/10/1985 | M | 5 | 12 | | 10 | | | 0 | |
| 2-JMS099.30 | 4/10/1985 | M | 7 | 12 | | 10 | | | 0 | |
| 2-JMS099.30 | 4/10/1985 | M | 9 | 12 | | 10.1 | | | 0 | |
| 2-JMS099.30 | 4/10/1985 | B | 10 | 12 | 7.3 | 10.1 | 9.7 | | 0 | |
| 2-JMS099.30 | 4/24/1985 | S | 1 | 23 | 7.4 | 6.3 | 7.8 | | 0 | 1.2 |
| 2-JMS099.30 | 4/24/1985 | M | 3 | 23 | | 6.3 | | | 0 | |
| 2-JMS099.30 | 4/24/1985 | M | 5 | 23 | | 6.3 | | | 0 | |
| 2-JMS099.30 | 4/24/1985 | M | 7 | 23 | | 6.3 | | | 0 | |
| 2-JMS099.30 | 4/24/1985 | M | 9 | 23 | | 6.2 | | | 0 | |
| 2-JMS099.30 | 4/24/1985 | B | 11 | 23 | 7.3 | 6.2 | 5.9 | | 0 | |
| 2-JMS099.30 | 5/8/1985 | S | 1 | 21.5 | 7.4 | 8.2 | 7.8 | | 0 | 1.3 |
| 2-JMS099.30 | 5/8/1985 | M | 3 | 21.5 | | 8.1 | | | 0 | |
| 2-JMS099.30 | 5/8/1985 | M | 5 | 21.5 | | 8.1 | | | 0 | |
| 2-JMS099.30 | 5/8/1985 | M | 7 | 21.5 | | 8.1 | | | 0 | |
| 2-JMS099.30 | 5/8/1985 | M | 9 | 21 | | 8.1 | | | 0 | |
| 2-JMS099.30 | 5/8/1985 | M | 11 | 21 | | 8.1 | | | 0 | |
| 2-JMS099.30 | 5/8/1985 | B | 12 | 21 | 7.3 | 7.9 | 7.7 | | 0 | |
| 2-JMS099.30 | 5/22/1985 | S | 1 | 22 | 7.3 | 7.7 | 7.2 | | 0 | 0.8 |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 5/22/1985 | M | 3 | 22 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 5/22/1985 | M | 5 | 22 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 5/22/1985 | M | 7 | 22 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 5/22/1985 | M | 9 | 22 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 5/22/1985 | B | 11 | 22 | 7.2 | 7.6 | 7.5 | | 0 | |
| 2-JMS099.30 | 6/19/1985 | S | 1 | 23.5 | 7.8 | 7.2 | 7.7 | | 0 | 0.9 |
| 2-JMS099.30 | 6/19/1985 | M | 5 | 23.5 | | 7.2 | | | 0 | |
| 2-JMS099.30 | 6/19/1985 | M | 7 | 23.5 | | 7.2 | | | 0 | |
| 2-JMS099.30 | 6/19/1985 | M | 9 | 23.5 | | 7.1 | | | 0 | |
| 2-JMS099.30 | 6/19/1985 | B | 11 | 23.5 | 7.57 | 7.1 | 7.8 | | 0 | |
| 2-JMS099.30 | 7/2/1985 | S | 1 | 24 | 7.82 | 6.2 | | | 0.1 | 1 |
| 2-JMS099.30 | 7/2/1985 | M | 3 | 24 | | 6.2 | | | 0.1 | |
| 2-JMS099.30 | 7/2/1985 | M | 5 | 24 | | 6.2 | | | 0.1 | |
| 2-JMS099.30 | 7/2/1985 | M | 7 | 24 | | 6.2 | | | 0.1 | |
| 2-JMS099.30 | 7/2/1985 | M | 9 | 24 | | 6.2 | | | 0.1 | |
| 2-JMS099.30 | 7/2/1985 | M | 11 | 24 | | 6.2 | | | 0.1 | |
| 2-JMS099.30 | 7/2/1985 | B | 12 | 24 | 7.84 | 6.2 | 5.6 | | 0.1 | |
| 2-JMS099.30 | 7/17/1985 | S | 1 | 26 | 7.57 | 6.4 | 6.3 | | 0 | 0.6 |
| 2-JMS099.30 | 7/17/1985 | M | 3 | 26 | | 6.3 | | | 0 | |
| 2-JMS099.30 | 7/17/1985 | M | 5 | 26 | | 6.3 | | | 0 | |
| 2-JMS099.30 | 7/17/1985 | M | 7 | 26 | | 6.3 | | | 0 | |
| 2-JMS099.30 | 7/17/1985 | M | 9 | 26 | | 6.3 | | | 0 | |
| 2-JMS099.30 | 7/17/1985 | M | 11 | 26 | | 6.2 | | | 0 | |
| 2-JMS099.30 | 7/17/1985 | B | 12 | 26 | 7.4 | 6.2 | 5.8 | | 0 | |
| 2-JMS099.30 | 8/5/1985 | S | 1 | 24.5 | 7.56 | 6.3 | | | 0 | 0.8 |
| 2-JMS099.30 | 8/5/1985 | M | 3 | 24.5 | | 6.2 | | | 0 | |
| 2-JMS099.30 | 8/5/1985 | M | 5 | 24.5 | | 6.2 | | | 0 | |
| 2-JMS099.30 | 8/5/1985 | M | 7 | 24.5 | | 6.2 | | | 0 | |
| 2-JMS099.30 | 8/5/1985 | M | 9 | 24.5 | | 6.1 | | | 0 | |
| 2-JMS099.30 | 8/5/1985 | B | 11 | 24.5 | 7.78 | 6.1 | | | 0 | |
| 2-JMS099.30 | 8/15/1985 | S | 1 | 28.5 | 8.07 | 8.2 | | | 0 | 1.2 |
| 2-JMS099.30 | 8/15/1985 | M | 3 | 28 | | 7.2 | | | 0 | |
| 2-JMS099.30 | 8/15/1985 | M | 5 | 27.5 | | 2.1 | | | 0 | |
| 2-JMS099.30 | 8/15/1985 | M | 7 | 27.5 | | 7.1 | | | 0 | |
| 2-JMS099.30 | 8/15/1985 | M | 9 | 27 | | 6.4 | | | 0 | |
| 2-JMS099.30 | 8/15/1985 | M | 11 | 27 | | 6.1 | | | 0 | |
| 2-JMS099.30 | 8/15/1985 | B | 13 | 27 | 7.56 | 6.1 | | | | |
| 2-JMS099.30 | 9/4/1985 | S | 3 | 25 | | 7.3 | | | 0 | |
| 2-JMS099.30 | 9/4/1985 | B | 11 | 23 | | 7.2 | | | 0 | |
| 2-JMS099.30 | 9/4/1985 | S | 1 | 25 | 7.61 | 7.6 | 6.7 | | 0 | |
| 2-JMS099.30 | 9/4/1985 | M | 5 | 23 | | 7.3 | | | 0 | |
| 2-JMS099.30 | 9/4/1985 | M | 7 | 23 | | 7.3 | | | 0 | |
| 2-JMS099.30 | 9/4/1985 | M | 9 | 23 | | 7.2 | | | 0 | |
| 2-JMS099.30 | 9/4/1985 | M | 11 | 23 | | 7.2 | | | 0 | |
| 2-JMS099.30 | 9/4/1985 | B | 12 | 23 | 7.57 | 7.1 | 6.3 | | 0 | 0.7 |
| 2-JMS099.30 | 9/17/1985 | S | 1 | 21 | 7.86 | 7.6 | | | 0 | |
| 2-JMS099.30 | 9/17/1985 | M | 3 | 20.5 | | 7.7 | | | 0 | |
| 2-JMS099.30 | 9/17/1985 | M | 5 | 20.5 | | 7.7 | | | 0 | |
| 2-JMS099.30 | 9/17/1985 | M | 7 | 20.5 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 9/17/1985 | M | 9 | 20.5 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 9/17/1985 | B | 11 | 20.5 | 7.93 | 7.6 | | | 0 | |
| 2-JMS099.30 | 10/2/1985 | S | 1 | 22 | 7.51 | 6.8 | 6.8 | | 0 | 0.6 |
| 2-JMS099.30 | 10/2/1985 | M | 3 | 21.5 | | 6.7 | | | 0 | |
| 2-JMS099.30 | 10/2/1985 | M | 5 | 21.5 | | 6.7 | | | 0 | |
| 2-JMS099.30 | 10/2/1985 | M | 7 | 21.5 | | 6.7 | | | 0 | |
| 2-JMS099.30 | 10/2/1985 | M | 9 | 21.5 | | 6.7 | | | 0 | |
| 2-JMS099.30 | 10/2/1985 | B | 11 | 21.5 | 7.37 | 6.7 | 6.6 | | 0 | 0.6 |
| 2-JMS099.30 | 10/16/1985 | S | 1 | 21 | 7.65 | 6.6 | 6.2 | | 0 | 0.6 |
| 2-JMS099.30 | 10/16/1985 | M | 3 | 20.5 | | 6.5 | | | 0 | |
| 2-JMS099.30 | 10/16/1985 | M | 5 | 20 | | 6.4 | | | 0 | |
| 2-JMS099.30 | 10/16/1985 | M | 7 | 20 | | 6.4 | | | 0 | |
| 2-JMS099.30 | 10/16/1985 | M | 9 | 20 | | 6.4 | | | 0 | |
| 2-JMS099.30 | 10/16/1985 | B | 11 | 20 | 7.59 | 6.4 | | | 0 | |
| 2-JMS099.30 | 11/18/1985 | S | 1 | 14.5 | 7.92 | 9.5 | 8.8 | | 0 | 0.6 |
| 2-JMS099.30 | 11/18/1985 | M | 3 | 14.5 | | 9.4 | | | 0 | |
| 2-JMS099.30 | 11/18/1985 | M | 5 | 14.5 | | 9.5 | | | 0 | |
| 2-JMS099.30 | 11/18/1985 | M | 7 | 14.5 | | 9.5 | | | 0 | |
| 2-JMS099.30 | 11/18/1985 | M | 9 | 14.5 | | 9.5 | | | 0 | |
| 2-JMS099.30 | 11/18/1985 | B | 11 | 14.5 | 7.9 | 9.4 | 8.8 | | 0 | |
| 2-JMS099.30 | 12/4/1985 | S | 1 | 9 | 7.88 | 10.8 | 10.4 | | 0 | 0.3 |
| 2-JMS099.30 | 12/4/1985 | M | 3 | 9 | | 10.8 | | | 0 | |
| 2-JMS099.30 | 12/4/1985 | M | 5 | 9 | | 10.8 | | | 0 | |
| 2-JMS099.30 | 12/4/1985 | M | 7 | 9 | | 10.7 | | | 0 | |
| 2-JMS099.30 | 12/4/1985 | M | 9 | 9 | | 10.7 | | | 0 | |
| 2-JMS099.30 | 12/4/1985 | M | 11 | 9 | | 10.7 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 12/4/1985 | B | 12 | 9 | 7.86 | 10.7 | 10.6 | | 0 | |
| 2-JMS099.30 | 1/15/1986 | S | 1 | 2.5 | 7.98 | 12.5 | 12.4 | | 0 | 1 |
| 2-JMS099.30 | 1/15/1986 | M | 3 | 2.5 | | 12.5 | | | 0 | |
| 2-JMS099.30 | 1/15/1986 | M | 5 | 2.5 | | 12.4 | | | 0 | |
| 2-JMS099.30 | 1/15/1986 | M | 7 | 2.5 | | 12.4 | | | 0 | |
| 2-JMS099.30 | 1/15/1986 | M | 9 | 2.5 | | 12 | | | 0 | |
| 2-JMS099.30 | 1/15/1986 | B | 11 | 2.5 | 7.77 | 12.2 | | | 0 | 1 |
| 2-JMS099.30 | 2/12/1986 | S | 1 | 5 | 7.84 | 11.6 | 11.4 | | 0 | 0.7 |
| 2-JMS099.30 | 2/12/1986 | M | 3 | 5 | | 11.5 | | | 0 | |
| 2-JMS099.30 | 2/12/1986 | M | 5 | 5 | | 11.5 | | | 0 | |
| 2-JMS099.30 | 2/12/1986 | M | 7 | 5 | | 11.5 | | | 0 | |
| 2-JMS099.30 | 2/12/1986 | M | 9 | 5 | | 11.5 | | | 0 | |
| 2-JMS099.30 | 2/12/1986 | M | 11 | 5 | | 11.5 | | | 0 | |
| 2-JMS099.30 | 2/12/1986 | B | 12 | 5 | 7.64 | 11.4 | 11.6 | | 0 | |
| 2-JMS099.30 | 3/12/1986 | S | 1 | 10 | 7.79 | 10.7 | 10 | | 0 | 1.1 |
| 2-JMS099.30 | 3/12/1986 | M | 3 | 10 | | 10.7 | | | 0 | |
| 2-JMS099.30 | 3/12/1986 | M | 5 | 10 | | 10.7 | | | 0 | |
| 2-JMS099.30 | 3/12/1986 | M | 7 | 10 | | 10.6 | | | 0 | |
| 2-JMS099.30 | 3/12/1986 | M | 9 | 10 | | 10.6 | | | 0 | |
| 2-JMS099.30 | 3/12/1986 | B | 11 | 10 | 7.52 | 10.6 | 10 | | 0 | |
| 2-JMS099.30 | 3/26/1986 | S | 1 | 12 | 8.08 | 10.6 | 10.3 | | 0 | 0.9 |
| 2-JMS099.30 | 3/26/1986 | M | 3 | 12 | | 10.6 | | | 0 | |
| 2-JMS099.30 | 3/26/1986 | M | 5 | 12 | | 10.5 | | | 0 | |
| 2-JMS099.30 | 3/26/1986 | M | 7 | 12 | | 10.5 | | | 0 | |
| 2-JMS099.30 | 3/26/1986 | M | 9 | 12 | | 10.5 | | | 0 | |
| 2-JMS099.30 | 3/26/1986 | B | 11 | 12 | 7.79 | 10.5 | 10.4 | | 0 | |
| 2-JMS099.30 | 4/10/1986 | S | 1 | 16.5 | 8.18 | | 8.1 | | 0 | 1 |
| 2-JMS099.30 | 4/10/1986 | M | 3 | 16.5 | | | | | 0 | |
| 2-JMS099.30 | 4/10/1986 | M | 5 | 16.5 | | | | | 0 | |
| 2-JMS099.30 | 4/10/1986 | M | 7 | 16.5 | | | | | 0 | |
| 2-JMS099.30 | 4/10/1986 | M | 9 | 16.5 | | 7.4 | | | 0 | |
| 2-JMS099.30 | 4/10/1986 | B | 10 | 16.5 | 8.25 | 7.4 | 7.9 | | 0 | |
| 2-JMS099.30 | 4/28/1986 | S | 1 | 18 | 8.54 | 7.7 | 6.9 | | 0 | 1.3 |
| 2-JMS099.30 | 4/28/1986 | M | 3 | 18 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 4/28/1986 | M | 5 | 18 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 4/28/1986 | M | 7 | 18 | | 7.5 | | | 0 | |
| 2-JMS099.30 | 4/28/1986 | M | 9 | 18 | | 7.4 | | | 0 | |
| 2-JMS099.30 | 4/28/1986 | M | 11 | 18 | | 7.4 | | | 0 | |
| 2-JMS099.30 | 4/28/1986 | B | 12 | 18 | 8.7 | 7.4 | 7.2 | | | 1.3 |
| 2-JMS099.30 | 5/8/1986 | S | 1 | 22 | 7.7 | 6.5 | 7.3 | | 0 | 1 |
| 2-JMS099.30 | 5/8/1986 | M | 3 | 22 | | 6.4 | | | 0 | |
| 2-JMS099.30 | 5/8/1986 | M | 5 | 22 | | 6.4 | | | 0 | |
| 2-JMS099.30 | 5/8/1986 | M | 7 | 22 | | 6.3 | | | 0 | |
| 2-JMS099.30 | 5/8/1986 | B | 9 | 22 | 7.31 | 5.9 | 6.6 | | 0 | |
| 2-JMS099.30 | 5/27/1986 | S | 1 | 22.5 | 7.97 | 7.8 | 7.1 | | 0 | 0.8 |
| 2-JMS099.30 | 5/27/1986 | M | 3 | 22 | | 7.7 | | | 0 | |
| 2-JMS099.30 | 5/27/1986 | M | 5 | 22 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 5/27/1986 | M | 7 | 22 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 5/27/1986 | M | 9 | 22 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 5/27/1986 | B | 11 | 22 | 7.91 | 7.6 | 7.2 | | 0 | |
| 2-JMS099.30 | 6/9/1986 | S | 1 | 27 | 7.84 | 6 | 6 | | 0 | 1 |
| 2-JMS099.30 | 6/9/1986 | M | 3 | 27 | | 5.8 | | | 0 | |
| 2-JMS099.30 | 6/9/1986 | M | 5 | 27 | | 5.7 | | | 0 | |
| 2-JMS099.30 | 6/9/1986 | M | 7 | 27 | | 5.7 | | | 0 | |
| 2-JMS099.30 | 6/9/1986 | B | 9 | 27 | 7.9 | 5.7 | 5 | | 0 | |
| 2-JMS099.30 | 6/24/1986 | S | 1 | 27 | 7.88 | 6.3 | 5.5 | | 0 | 0.8 |
| 2-JMS099.30 | 6/24/1986 | M | 3 | 27 | | 6 | | | 0 | |
| 2-JMS099.30 | 6/24/1986 | M | 5 | 27 | | 5.7 | | | 0 | |
| 2-JMS099.30 | 6/24/1986 | M | 7 | 27 | | 5.5 | | | 0 | |
| 2-JMS099.30 | 6/24/1986 | M | 9 | 27 | | 5.7 | | | 0 | |
| 2-JMS099.30 | 6/24/1986 | B | 10 | 27 | 7.81 | 5.7 | 5.2 | | 0 | |
| 2-JMS099.30 | 7/8/1986 | S | 1 | 27 | 7.68 | 7.56 | 8.5 | | 0 | 0.9 |
| 2-JMS099.30 | 7/8/1986 | M | 3 | 26.7 | | 7 | | | 0 | |
| 2-JMS099.30 | 7/8/1986 | M | 5 | 26.7 | | 6.97 | | | 0 | |
| 2-JMS099.30 | 7/8/1986 | M | 7 | 26.6 | | 6.84 | | | 0 | |
| 2-JMS099.30 | 7/8/1986 | B | 9 | 26.6 | 8.23 | 6.76 | 4.6 | | 0 | |
| 2-JMS099.30 | 7/22/1986 | S | 1 | 30.5 | 8.02 | 6.4 | 6.3 | | 0 | 1.2 |
| 2-JMS099.30 | 7/22/1986 | M | 3 | 30.5 | | 6.1 | | | 0 | |
| 2-JMS099.30 | 7/22/1986 | M | 5 | 30.5 | | 5.8 | | | 0 | |
| 2-JMS099.30 | 7/22/1986 | M | 7 | 30.5 | | 5.8 | | | 0 | |
| 2-JMS099.30 | 7/22/1986 | M | 9 | 30.5 | | 5.8 | | | 0 | |
| 2-JMS099.30 | 7/22/1986 | B | 11 | 30.5 | 7.86 | 5.7 | 5.5 | | 0 | |
| 2-JMS099.30 | 8/6/1986 | S | 1 | 30 | 7.83 | | 6.9 | | 0 | 1 |
| 2-JMS099.30 | 8/6/1986 | M | 3 | 30 | | | | | 0 | |
| 2-JMS099.30 | 8/6/1986 | M | 5 | 30 | | | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 8/6/1986 | M | 7 | 29.5 | | | | | 0 | |
| 2-JMS099.30 | 8/6/1986 | M | 9 | 29.5 | | | | | 0 | |
| 2-JMS099.30 | 8/6/1986 | B | 10 | 29.5 | 7.76 | | 5 | | 0 | 1 |
| 2-JMS099.30 | 8/20/1986 | S | 1 | 27 | 7.35 | 5.1 | 5 | | 0 | 0.8 |
| 2-JMS099.30 | 8/20/1986 | M | 3 | 27 | | 5.1 | | | 0 | |
| 2-JMS099.30 | 8/20/1986 | M | 5 | 27 | | 5 | | | 0 | |
| 2-JMS099.30 | 8/20/1986 | M | 7 | 27 | | 5 | | | 0 | |
| 2-JMS099.30 | 8/20/1986 | M | 9 | 27 | | 5 | | | 0 | |
| 2-JMS099.30 | 8/20/1986 | M | 11 | 27 | | 5 | | | 0 | |
| 2-JMS099.30 | 8/20/1986 | B | 12 | 27 | 7.4 | 5 | 5.3 | | 0 | |
| 2-JMS099.30 | 9/9/1986 | S | 1 | 24 | 8.1 | 8 | 7.8 | | 0 | 1.4 |
| 2-JMS099.30 | 9/9/1986 | M | 3 | 23.5 | | 7.7 | | | 0 | |
| 2-JMS099.30 | 9/9/1986 | M | 5 | 23.5 | | 7.7 | | | 0 | |
| 2-JMS099.30 | 9/9/1986 | M | 7 | 23.5 | | 7.7 | | | 0 | |
| 2-JMS099.30 | 9/9/1986 | M | 9 | 23.5 | | 7.8 | | | 0 | |
| 2-JMS099.30 | 9/9/1986 | B | 10 | 23.5 | 7.96 | 7.8 | 7.2 | | 0 | |
| 2-JMS099.30 | 9/23/1986 | S | 1 | 21.7 | 8.07 | | 8.7 | | 0 | 1.2 |
| 2-JMS099.30 | 9/23/1986 | M | 3 | 21.6 | | | | | 0 | |
| 2-JMS099.30 | 9/23/1986 | M | 5 | 21.4 | | | | | 0 | |
| 2-JMS099.30 | 9/23/1986 | M | 7 | 21.3 | | | | | 0 | |
| 2-JMS099.30 | 9/23/1986 | M | 9 | 21.3 | | | | | 0 | |
| 2-JMS099.30 | 9/23/1986 | B | 10 | 21.3 | 8.19 | | 7.3 | | 0 | |
| 2-JMS099.30 | 10/7/1986 | S | 1 | 25.6 | 7.82 | 4.9 | 6.5 | | 0 | 1.2 |
| 2-JMS099.30 | 10/7/1986 | M | 3 | 25.4 | | 4.6 | | | 0 | |
| 2-JMS099.30 | 10/7/1986 | M | 5 | 25.4 | | 4.6 | | | 0 | |
| 2-JMS099.30 | 10/7/1986 | M | 7 | 25.4 | | 4.6 | | | 0 | |
| 2-JMS099.30 | 10/7/1986 | M | 9 | 25.4 | | 4.6 | | | 0 | |
| 2-JMS099.30 | 10/7/1986 | B | 11 | 25.4 | 7.83 | 4.6 | 6.2 | | 0 | |
| 2-JMS099.30 | 10/28/1986 | S | 1 | 17.1 | 7.89 | 8 | 7.8 | | 0 | |
| 2-JMS099.30 | 10/28/1986 | M | 3 | 17.1 | | 7.9 | | | 0 | |
| 2-JMS099.30 | 10/28/1986 | M | 5 | 16.8 | | 7.8 | | | 0 | |
| 2-JMS099.30 | 10/28/1986 | M | 7 | 16.8 | | 7.8 | | | 0 | |
| 2-JMS099.30 | 10/28/1986 | M | 9 | 16.8 | | 7.8 | | | 0 | |
| 2-JMS099.30 | 10/28/1986 | B | 11 | 16.8 | 7.98 | 7.7 | 7.5 | | | |
| 2-JMS099.30 | 11/25/1986 | S | 1 | 8.5 | 8.07 | 11.2 | | | 0 | 1.6 |
| 2-JMS099.30 | 11/25/1986 | M | 3 | 8.5 | | 11.2 | | | 0 | |
| 2-JMS099.30 | 11/25/1986 | M | 5 | 8.5 | | 11.2 | | | 0 | |
| 2-JMS099.30 | 11/25/1986 | M | 7 | 8 | | 11.2 | | | 0 | |
| 2-JMS099.30 | 11/25/1986 | M | 9 | 8 | | 11.1 | | | 0 | |
| 2-JMS099.30 | 11/25/1986 | B | 11 | 8 | 7.93 | 11.2 | | | 0 | |
| 2-JMS099.30 | 12/22/1986 | S | 1 | 7.5 | 8.18 | 12.1 | 12.1 | | 0 | 1.3 |
| 2-JMS099.30 | 12/22/1986 | M | 3 | 4.5 | | 12.1 | | | 0 | |
| 2-JMS099.30 | 12/22/1986 | M | 5 | 4.5 | | 12.1 | | | 0 | |
| 2-JMS099.30 | 12/22/1986 | M | 7 | 4.5 | | 12.1 | | | 0 | |
| 2-JMS099.30 | 12/22/1986 | M | 9 | 4.5 | | 12.1 | | | 0 | |
| 2-JMS099.30 | 12/22/1986 | B | 11 | 4.5 | 8.1 | 12.1 | 12.5 | | 0 | |
| 2-JMS099.30 | 1/5/1987 | S | 1 | 4 | 7.15 | 12.7 | 13 | | 0 | 0.5 |
| 2-JMS099.30 | 1/5/1987 | M | 3 | 4 | | 12.6 | | | 0 | |
| 2-JMS099.30 | 1/5/1987 | M | 5 | 4 | | 12.6 | | | 0 | |
| 2-JMS099.30 | 1/5/1987 | M | 7 | 4 | | 12.6 | | | 0 | |
| 2-JMS099.30 | 1/5/1987 | M | 9 | 4 | | 12.6 | | | 0 | |
| 2-JMS099.30 | 1/5/1987 | B | 11 | 4 | 7.12 | 12.6 | 12.8 | | 0 | |
| 2-JMS099.30 | 3/4/1987 | S | 1 | 7.2 | 7.81 | 12.4 | 12.2 | | 0 | 0.4 |
| 2-JMS099.30 | 3/4/1987 | M | 3 | 7.2 | | 12.3 | | | 0 | |
| 2-JMS099.30 | 3/4/1987 | M | 5 | 7.2 | | 12.4 | | | 0 | |
| 2-JMS099.30 | 3/4/1987 | M | 7 | 7.2 | | 12.4 | | | 0 | |
| 2-JMS099.30 | 3/4/1987 | M | 9 | 7.2 | | 12.4 | | | 0 | |
| 2-JMS099.30 | 3/4/1987 | M | 11 | 7.2 | | 12.4 | | | 0 | |
| 2-JMS099.30 | 3/4/1987 | B | 13 | 7.2 | 7.7 | 12.4 | 11.5 | | 0 | |
| 2-JMS099.30 | 3/18/1987 | S | 1 | 9.1 | 7.87 | 12.1 | 11.1 | | 0 | 1.7 |
| 2-JMS099.30 | 3/18/1987 | M | 3 | 8.9 | | 12.1 | | | 0 | |
| 2-JMS099.30 | 3/18/1987 | M | 5 | 8.9 | | 12.1 | | | 0 | |
| 2-JMS099.30 | 3/18/1987 | M | 7 | 8.9 | | 12.1 | | | 0 | |
| 2-JMS099.30 | 3/18/1987 | M | 9 | 8.8 | | 12.2 | | | 0 | |
| 2-JMS099.30 | 3/18/1987 | B | 11 | 8.9 | 7.78 | 12.2 | 11.9 | | 0 | |
| 2-JMS099.30 | 4/8/1987 | S | 1 | 9.5 | 7.57 | 12.5 | 11.7 | | 0 | 1.3 |
| 2-JMS099.30 | 4/8/1987 | M | 3 | 9.4 | | 12.5 | | | 0 | |
| 2-JMS099.30 | 4/8/1987 | M | 5 | 9.4 | | 12.4 | | | 0 | |
| 2-JMS099.30 | 4/8/1987 | M | 7 | 9.4 | | 12.4 | | | 0 | |
| 2-JMS099.30 | 4/8/1987 | M | 9 | 9.4 | | 12.4 | | | 0 | |
| 2-JMS099.30 | 4/8/1987 | B | 11 | 9.4 | 7.71 | 12.4 | 11.1 | | 0 | |
| 2-JMS099.30 | 4/14/1987 | S | 1 | 12 | 6.84 | 7.6 | 8.9 | | 0 | 1 |
| 2-JMS099.30 | 4/14/1987 | M | 3 | 12 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 4/14/1987 | M | 5 | 12 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 4/14/1987 | M | 7 | 12 | | 7.5 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 4/14/1987 | M | 9 | 12 | | 7.5 | | | 0 | |
| 2-JMS099.30 | 4/14/1987 | B | 11 | 12 | 7.02 | 7.5 | 8.2 | | 0 | |
| 2-JMS099.30 | 5/6/1987 | S | 1 | 16.5 | 7.78 | 9.8 | 9.1 | | 0 | 0.8 |
| 2-JMS099.30 | 5/6/1987 | M | 3 | 16.5 | | 9.8 | | | 0 | |
| 2-JMS099.30 | 5/6/1987 | M | 5 | 16.5 | | 9.7 | | | 0 | |
| 2-JMS099.30 | 5/6/1987 | M | 7 | 16.5 | | 9.6 | | | 0 | |
| 2-JMS099.30 | 5/6/1987 | M | 9 | 16.5 | | 9.6 | | | 0 | |
| 2-JMS099.30 | 5/6/1987 | M | 11 | 16.5 | | 9.6 | | | 0 | |
| 2-JMS099.30 | 5/6/1987 | B | 12 | 16.5 | 7.61 | 9.6 | 9.5 | | 0 | |
| 2-JMS099.30 | 5/18/1987 | S | 1 | 23.38 | 9.22 | 10 | 8.7 | | 0 | 1.1 |
| 2-JMS099.30 | 5/18/1987 | M | 3 | 22.9 | | 9.4 | | | 0 | |
| 2-JMS099.30 | 5/18/1987 | M | 5 | 22.6 | | 9.1 | | | 0 | |
| 2-JMS099.30 | 5/18/1987 | M | 7 | 22.4 | | 9.1 | | | 0 | |
| 2-JMS099.30 | 5/18/1987 | M | 9 | 22.3 | | 9 | | | 0 | |
| 2-JMS099.30 | 5/18/1987 | B | 10 | 22 | 8.81 | 9 | 9.2 | | 0 | |
| 2-JMS099.30 | 6/1/1987 | S | 1 | 28.4 | | 7.63 | 7.4 | | 0 | |
| 2-JMS099.30 | 6/1/1987 | M | 3 | 28 | | 7.08 | | | 0 | |
| 2-JMS099.30 | 6/1/1987 | M | 5 | 28 | | 7.1 | | | 0 | |
| 2-JMS099.30 | 6/1/1987 | M | 7 | 28 | | 7.13 | | | 0 | |
| 2-JMS099.30 | 6/1/1987 | M | 9 | 28 | | 7.16 | | | 0 | |
| 2-JMS099.30 | 6/1/1987 | B | 11 | 28 | 7.35 | 7.14 | 6.9 | | 0 | |
| 2-JMS099.30 | 6/15/1987 | S | 1 | 27.1 | 7.96 | 6.6 | 5.7 | | 0 | 0.8 |
| 2-JMS099.30 | 6/15/1987 | M | 3 | 26.8 | | 6.3 | | | 0 | |
| 2-JMS099.30 | 6/15/1987 | M | 5 | 26.7 | | 6.1 | | | 0 | |
| 2-JMS099.30 | 6/15/1987 | M | 7 | 26.6 | | 5.9 | | | 0 | |
| 2-JMS099.30 | 6/15/1987 | M | 9 | 26.6 | | 5.8 | | | 0 | |
| 2-JMS099.30 | 6/15/1987 | B | 11 | 26.6 | 7.96 | 6.1 | 5.5 | | 0 | |
| 2-JMS099.30 | 6/29/1987 | S | 1 | 28 | 7.38 | 5.7 | 6.1 | | 0 | 1 |
| 2-JMS099.30 | 6/29/1987 | M | 3 | 27.5 | | 5.3 | | | 0 | |
| 2-JMS099.30 | 6/29/1987 | M | 5 | 27.5 | | 5.3 | | | 0 | |
| 2-JMS099.30 | 6/29/1987 | M | 7 | 27.5 | | 5.3 | | | 0 | |
| 2-JMS099.30 | 6/29/1987 | M | 9 | 27.5 | | 5.3 | | | 0 | |
| 2-JMS099.30 | 6/29/1987 | B | 11 | 27.5 | 7.4 | 5.3 | 4.9 | | 0 | |
| 2-JMS099.30 | 7/13/1987 | S | 1 | 32 | 8.24 | 5.8 | 5.7 | | 0 | 1.2 |
| 2-JMS099.30 | 7/13/1987 | M | 3 | 31.5 | | 5.4 | | | 0 | |
| 2-JMS099.30 | 7/13/1987 | M | 5 | 31 | | 5.3 | | | 0 | |
| 2-JMS099.30 | 7/13/1987 | M | 7 | 31 | | 5.3 | | | 0 | |
| 2-JMS099.30 | 7/13/1987 | M | 9 | 31 | | 5.3 | | | 0 | |
| 2-JMS099.30 | 7/13/1987 | B | 11 | 31 | 8.2 | 5.2 | 5.2 | | 0 | |
| 2-JMS099.30 | 8/11/1987 | S | 1 | 30.8 | | 7.47 | 6.2 | | 0 | 1 |
| 2-JMS099.30 | 8/11/1987 | M | 3 | 29.9 | | 5.87 | | | 0 | |
| 2-JMS099.30 | 8/11/1987 | M | 5 | 29.8 | | 5.76 | | | 0 | |
| 2-JMS099.30 | 8/11/1987 | M | 7 | 29.8 | | 5.75 | | | 0 | |
| 2-JMS099.30 | 8/11/1987 | B | 9 | 29.8 | 8.28 | 5.66 | 5.3 | | 0 | |
| 2-JMS099.30 | 8/25/1987 | S | 1 | 27.7 | 7.78 | 4 | 3.9 | | 0 | 0.9 |
| 2-JMS099.30 | 8/25/1987 | M | 3 | 27.7 | | 3.8 | | | 0 | |
| 2-JMS099.30 | 8/25/1987 | M | 5 | 27.7 | | 3.9 | | | 0 | |
| 2-JMS099.30 | 8/25/1987 | M | 7 | 27.7 | | 3.9 | | | 0 | |
| 2-JMS099.30 | 8/25/1987 | M | 9 | 27.6 | | 3.9 | | | 0 | |
| 2-JMS099.30 | 8/25/1987 | B | 11 | 27.6 | 8.28 | 3.8 | 4 | | 0 | |
| 2-JMS099.30 | 10/8/1987 | S | 1 | 17.3 | 7.38 | 8.4 | 8.9 | | 0 | 0.8 |
| 2-JMS099.30 | 10/8/1987 | M | 3 | 17.3 | | 8.4 | | | 0 | |
| 2-JMS099.30 | 10/8/1987 | M | 5 | 17.2 | | 8.4 | | | 0 | |
| 2-JMS099.30 | 10/8/1987 | M | 7 | 17.2 | | 8.4 | | | 0 | |
| 2-JMS099.30 | 10/8/1987 | B | 9 | 17.2 | 7.38 | 8.4 | 8.6 | | 0 | |
| 2-JMS099.30 | 10/27/1987 | S | 1 | 14.4 | | 9.8 | | | 0 | 1.1 |
| 2-JMS099.30 | 10/27/1987 | M | 3 | 14.4 | | 9.5 | | | 0 | |
| 2-JMS099.30 | 10/27/1987 | M | 5 | 14.4 | | 9.4 | | | 0 | |
| 2-JMS099.30 | 10/27/1987 | M | 7 | 14.4 | | 9.4 | | | 0 | |
| 2-JMS099.30 | 10/27/1987 | M | 9 | 14.4 | | 9.5 | | | 0 | |
| 2-JMS099.30 | 10/27/1987 | B | 10 | 14.4 | | 9.5 | | | 0 | |
| 2-JMS099.30 | 11/9/1987 | S | 1 | 14 | 7.7 | 8.8 | 8.7 | | 0 | 1 |
| 2-JMS099.30 | 11/9/1987 | M | 3 | 14 | | 8.7 | | | 0 | |
| 2-JMS099.30 | 11/9/1987 | M | 5 | 14 | | 8.8 | | | 0 | |
| 2-JMS099.30 | 11/9/1987 | M | 7 | 14 | | 8.7 | | | 0 | |
| 2-JMS099.30 | 11/9/1987 | M | 9 | 14 | | 8.7 | | | 0 | |
| 2-JMS099.30 | 11/9/1987 | B | 10 | 14 | 7.87 | 8.7 | 8.8 | | 0 | |
| 2-JMS099.30 | 3/7/1988 | S | 1 | | | | | | | |
| 2-JMS099.30 | 5/16/1988 | S | 11 | | | | | | | |
| 2-JMS099.30 | 6/29/1988 | S | 1 | 25.5 | 7.83 | 5.01 | | | 0 | 0.6 |
| 2-JMS099.30 | 6/29/1988 | M | 3 | 25.5 | | 5.02 | | | 0 | |
| 2-JMS099.30 | 6/29/1988 | M | 5 | 25.5 | | 4.78 | | | 0 | |
| 2-JMS099.30 | 6/29/1988 | M | 7 | 25.3 | | 5 | | | 0 | |
| 2-JMS099.30 | 6/29/1988 | B | 8 | 25.4 | 7.83 | 5.03 | | | 0 | |
| 2-JMS099.30 | 7/18/1988 | S | 1 | 30 | 7.47 | 6.9 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 7/18/1988 | M | 3 | 30 | | 4.8 | | | 0 | |
| 2-JMS099.30 | 7/18/1988 | M | 5 | 30 | | 4.5 | | | 0 | |
| 2-JMS099.30 | 7/18/1988 | M | 7 | 30 | | 4.3 | | | 0 | |
| 2-JMS099.30 | 7/18/1988 | M | 9 | 30 | | 4.4 | | | 0 | |
| 2-JMS099.30 | 7/18/1988 | B | 11 | 30 | 7.54 | 4.3 | | | 0 | |
| 2-JMS099.30 | 8/1/1988 | S | 1 | 28.4 | 7.38 | 6.47 | | | 0 | 0.7 |
| 2-JMS099.30 | 8/1/1988 | M | 3 | 28.3 | | 6.45 | | | 0 | |
| 2-JMS099.30 | 8/1/1988 | M | 5 | 28.2 | | 6.2 | | | 0 | |
| 2-JMS099.30 | 8/1/1988 | M | 7 | 28.1 | | 6.1 | | | 0 | |
| 2-JMS099.30 | 8/1/1988 | B | 9 | 28 | 7.33 | 5.97 | | | 0 | |
| 2-JMS099.30 | 8/15/1988 | S | 1 | 29.2 | 7.84 | 7.28 | | | 0 | 0.6 |
| 2-JMS099.30 | 8/15/1988 | M | 3 | 28.5 | | 5.2 | | | 0 | |
| 2-JMS099.30 | 8/15/1988 | M | 5 | 28.5 | | 4.84 | | | 0 | |
| 2-JMS099.30 | 8/15/1988 | M | 7 | 28.4 | | 4.78 | | | 0 | |
| 2-JMS099.30 | 8/15/1988 | M | 9 | 28.4 | | 3.54 | | | 0 | |
| 2-JMS099.30 | 8/15/1988 | B | 10 | 28.4 | 7.66 | 3.37 | | | 0 | |
| 2-JMS099.30 | 9/12/1988 | S | 1 | 23.8 | 7.66 | 7.6 | | | 0 | 0.4 |
| 2-JMS099.30 | 9/12/1988 | M | 3 | 23.6 | | 7.3 | | | 0 | |
| 2-JMS099.30 | 9/12/1988 | M | 5 | 23.6 | | 7.3 | | | 0 | |
| 2-JMS099.30 | 9/12/1988 | M | 7 | 23.6 | | 7.3 | | | 0 | |
| 2-JMS099.30 | 9/12/1988 | M | 9 | 23.5 | | 7.2 | | | 0 | |
| 2-JMS099.30 | 9/12/1988 | B | 11 | 23.5 | 7.5 | 7.2 | | | 0 | |
| 2-JMS099.30 | 9/27/1988 | S | 1 | 23.7 | 7.38 | 6.1 | | | 0 | 1 |
| 2-JMS099.30 | 9/27/1988 | M | 3 | 23.6 | | 5.9 | | | 0 | |
| 2-JMS099.30 | 9/27/1988 | M | 5 | 23.6 | | 5.9 | | | 0 | |
| 2-JMS099.30 | 9/27/1988 | M | 7 | 23.6 | | 5.9 | | | 0 | |
| 2-JMS099.30 | 9/27/1988 | M | 9 | 23.6 | | 5.8 | | | 0 | |
| 2-JMS099.30 | 9/27/1988 | B | 11 | 23.6 | 7.31 | 5.8 | | | 0 | |
| 2-JMS099.30 | 10/11/1988 | S | 1 | 17.4 | 7.57 | 7.91 | | | 0 | 0.9 |
| 2-JMS099.30 | 10/11/1988 | M | 3 | 17.3 | | 7.9 | | | 0 | |
| 2-JMS099.30 | 10/11/1988 | M | 5 | 17.3 | | 7.92 | | | 0 | |
| 2-JMS099.30 | 10/11/1988 | M | 7 | 17.3 | | 7.89 | | | 0 | |
| 2-JMS099.30 | 10/11/1988 | B | 9 | 17.3 | | 7.89 | | | | |
| 2-JMS099.30 | 10/26/1988 | S | 1 | 14 | 7.58 | 8.33 | | | 0 | 0.6 |
| 2-JMS099.30 | 10/26/1988 | M | 3 | 14 | | 8.28 | | | 0 | |
| 2-JMS099.30 | 10/26/1988 | M | 5 | 13.9 | | 8.31 | | | 0 | |
| 2-JMS099.30 | 10/26/1988 | M | 7 | 13.9 | | 8.31 | | | 0 | |
| 2-JMS099.30 | 10/26/1988 | M | 9 | 13.9 | | 8.76 | | | 0 | |
| 2-JMS099.30 | 10/26/1988 | B | 11 | 13.9 | 7.44 | 8.4 | | | 0 | |
| 2-JMS099.30 | 11/14/1988 | S | 1 | 12 | 7.52 | 9.92 | | | 0 | 0.7 |
| 2-JMS099.30 | 11/14/1988 | M | 3 | 11.9 | | 9.94 | | | 0 | |
| 2-JMS099.30 | 11/14/1988 | M | 5 | 11.8 | | 9.91 | | | 0 | |
| 2-JMS099.30 | 11/14/1988 | M | 7 | 11.8 | | 9.9 | | | 0 | |
| 2-JMS099.30 | 11/14/1988 | M | 9 | 11.8 | | 9.9 | | | 0 | |
| 2-JMS099.30 | 11/14/1988 | B | 11 | 11.8 | 7.49 | 9.91 | | | 0 | |
| 2-JMS099.30 | 12/20/1988 | S | 1 | 3.13 | 8.02 | 13.52 | | | 0 | 0.7 |
| 2-JMS099.30 | 12/20/1988 | M | 3 | 3.05 | | 13.72 | | | 0 | |
| 2-JMS099.30 | 12/20/1988 | M | 5 | 3.05 | | 13.66 | | | 0 | |
| 2-JMS099.30 | 12/20/1988 | M | 7 | 2.98 | | 13.69 | | | 0 | |
| 2-JMS099.30 | 12/20/1988 | M | 9 | 2.97 | | 13.65 | | | 0 | |
| 2-JMS099.30 | 12/20/1988 | B | 11 | 2.94 | 7.64 | 13.68 | | | 0 | |
| 2-JMS099.30 | 1/11/1989 | S | 1 | 6.12 | 7.45 | 12 | | | 0 | 1.3 |
| 2-JMS099.30 | 1/11/1989 | M | 3 | 6.1 | | 12 | | | 0 | |
| 2-JMS099.30 | 1/11/1989 | M | 5 | 6.09 | | 11.95 | | | 0 | |
| 2-JMS099.30 | 1/11/1989 | M | 7 | 6.07 | | 11.96 | | | 0 | |
| 2-JMS099.30 | 1/11/1989 | M | 9 | 6.03 | | 11.99 | | | 0 | |
| 2-JMS099.30 | 1/11/1989 | B | 11 | 6.02 | 7.45 | 12.01 | | | 0 | |
| 2-JMS099.30 | 2/8/1989 | S | 1 | 6.87 | 7.59 | 11.84 | | | 0 | 1.4 |
| 2-JMS099.30 | 2/8/1989 | M | 3 | 6.85 | | 11.86 | | | 0 | |
| 2-JMS099.30 | 2/8/1989 | M | 5 | 6.84 | | 11.86 | | | 0 | |
| 2-JMS099.30 | 2/8/1989 | M | 7 | 6.84 | | 11.81 | | | 0 | |
| 2-JMS099.30 | 2/8/1989 | M | 9 | 6.84 | | 11.81 | | | 0 | |
| 2-JMS099.30 | 2/8/1989 | B | 11 | 6.85 | 7.59 | 11.8 | | | 0 | |
| 2-JMS099.30 | 3/15/1989 | S | 1 | 8.26 | 7.22 | 11.63 | | | 0 | 0.7 |
| 2-JMS099.30 | 3/15/1989 | M | 3 | 8.14 | | 11.63 | | | 0 | |
| 2-JMS099.30 | 3/15/1989 | M | 5 | 8.09 | | 11.64 | | | 0 | |
| 2-JMS099.30 | 3/15/1989 | M | 7 | 8.05 | | 11.67 | | | 0 | |
| 2-JMS099.30 | 3/15/1989 | M | 9 | 8.04 | | 11.63 | | | 0 | |
| 2-JMS099.30 | 3/15/1989 | M | 11 | 8.08 | | 11.54 | | | 0 | |
| 2-JMS099.30 | 3/15/1989 | B | 12 | 8.04 | 7.28 | 11.68 | | | 0 | |
| 2-JMS099.30 | 3/28/1989 | S | 1 | 13.03 | 7.37 | 10.4 | | | 0 | 0.6 |
| 2-JMS099.30 | 3/28/1989 | M | 3 | 12.94 | | 10.4 | | | 0 | |
| 2-JMS099.30 | 3/28/1989 | M | 5 | 12.95 | | 10.41 | | | 0 | |
| 2-JMS099.30 | 3/28/1989 | M | 7 | 12.88 | | 10.41 | | | 0 | |
| 2-JMS099.30 | 3/28/1989 | B | 9 | 12.81 | 7.37 | 10.4 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 4/13/1989 | S | 1 | 12.12 | 7.13 | 10.52 | | | 0 | 1 |
| 2-JMS099.30 | 4/13/1989 | M | 3 | 11.99 | | 10.52 | | | 0 | |
| 2-JMS099.30 | 4/13/1989 | M | 5 | 11.97 | | 10.49 | | | 0 | |
| 2-JMS099.30 | 4/13/1989 | M | 7 | 11.89 | | 10.49 | | | 0 | |
| 2-JMS099.30 | 4/13/1989 | M | 9 | 11.78 | | 10.49 | | | 0 | |
| 2-JMS099.30 | 4/13/1989 | B | 10 | 11.68 | 7.21 | 10.49 | | | 0 | |
| 2-JMS099.30 | 2/13/1990 | S | 1 | 9.25 | 7.4 | 11.23 | | | 0 | 0.3 |
| 2-JMS099.30 | 2/13/1990 | M | 3 | 9.24 | | 11.18 | | | 0 | |
| 2-JMS099.30 | 2/13/1990 | M | 5 | 9.22 | | 11.19 | | | 0 | |
| 2-JMS099.30 | 2/13/1990 | M | 7 | 9.24 | | 11.19 | | | 0 | |
| 2-JMS099.30 | 2/13/1990 | M | 9 | 9.27 | | 11.17 | | | 0 | |
| 2-JMS099.30 | 2/13/1990 | B | 10 | 9.31 | 7.43 | 11.02 | | | 0 | |
| 2-JMS099.30 | 3/13/1990 | S | 1 | 15.18 | 7.95 | 10.21 | | | 0 | 1.4 |
| 2-JMS099.30 | 3/13/1990 | M | 3 | 14.83 | | 10.16 | | | 0 | |
| 2-JMS099.30 | 3/13/1990 | M | 5 | 14.86 | | 10.15 | | | 0 | |
| 2-JMS099.30 | 3/13/1990 | M | 7 | 14.88 | | 10.17 | | | 0 | |
| 2-JMS099.30 | 3/13/1990 | M | 9 | 14.94 | | 10.15 | | | 0 | |
| 2-JMS099.30 | 3/13/1990 | B | 11 | 14.9 | 7.72 | 10.1 | | | 0 | |
| 2-JMS099.30 | 3/28/1990 | S | 1 | 11.73 | 7.44 | 10.6 | | | 0 | 0.8 |
| 2-JMS099.30 | 3/28/1990 | M | 3 | 11.66 | | 10.6 | | | 0 | |
| 2-JMS099.30 | 3/28/1990 | M | 5 | 11.74 | | 10.65 | | | 0 | |
| 2-JMS099.30 | 3/28/1990 | M | 7 | 11.63 | | 10.61 | | | 0 | |
| 2-JMS099.30 | 3/28/1990 | M | 9 | 11.63 | | 10.63 | | | 0 | |
| 2-JMS099.30 | 3/28/1990 | B | 11 | 11.58 | 7.43 | 10.65 | | | 0 | |
| 2-JMS099.30 | 4/10/1990 | S | 1 | 12.11 | 7.15 | 10.58 | | | 0 | 0.6 |
| 2-JMS099.30 | 4/10/1990 | M | 3 | 12.09 | | 10.57 | | | 0 | |
| 2-JMS099.30 | 4/10/1990 | M | 5 | 12.09 | | 10.53 | | | 0 | |
| 2-JMS099.30 | 4/10/1990 | M | 7 | 12.06 | | 10.55 | | | 0 | |
| 2-JMS099.30 | 4/10/1990 | M | 9 | 12.09 | | 10.54 | | | 0 | |
| 2-JMS099.30 | 4/10/1990 | B | 10 | 12.08 | 7.16 | 10.45 | | | 0 | |
| 2-JMS099.30 | 4/25/1990 | S | 1 | 20.07 | 7.5 | 8.62 | | | 0 | 1 |
| 2-JMS099.30 | 4/25/1990 | M | 3 | 20.01 | | 8.66 | | | 0 | |
| 2-JMS099.30 | 4/25/1990 | M | 5 | 19.99 | | 8.71 | | | 0 | |
| 2-JMS099.30 | 4/25/1990 | M | 7 | 19.99 | | 8.71 | | | 0 | |
| 2-JMS099.30 | 4/25/1990 | M | 9 | 20 | | 8.7 | | | 0 | |
| 2-JMS099.30 | 4/25/1990 | B | 11 | 20 | 7.49 | 8.71 | | | 0 | |
| 2-JMS099.30 | 5/9/1990 | S | 1 | 21.95 | 7.6 | 8.12 | | | 0 | 0.9 |
| 2-JMS099.30 | 5/9/1990 | M | 3 | 21.85 | | 8.11 | | | 0 | |
| 2-JMS099.30 | 5/9/1990 | M | 5 | 21.83 | | 8.12 | | | 0 | |
| 2-JMS099.30 | 5/9/1990 | M | 7 | 21.78 | | 8.13 | | | 0 | |
| 2-JMS099.30 | 5/9/1990 | M | 9 | 21.74 | | 8.16 | | | 0 | |
| 2-JMS099.30 | 5/9/1990 | B | 11 | 21.63 | 7.5 | 8.19 | | | 0 | |
| 2-JMS099.30 | 5/31/1990 | S | 1 | 17.94 | 7.17 | 9.13 | | | 0 | 0.3 |
| 2-JMS099.30 | 5/31/1990 | M | 3 | 17.94 | | 9.13 | | | 0 | |
| 2-JMS099.30 | 5/31/1990 | M | 5 | 17.95 | | 9.16 | | | 0 | |
| 2-JMS099.30 | 5/31/1990 | M | 7 | 17.96 | | 9.15 | | | 0 | |
| 2-JMS099.30 | 5/31/1990 | M | 9 | 17.92 | | 9.16 | | | 0 | |
| 2-JMS099.30 | 5/31/1990 | M | 11 | 17.94 | | 9.13 | | | 0 | |
| 2-JMS099.30 | 5/31/1990 | B | 12 | 17.94 | 7.3 | 9.15 | | | 0 | |
| 2-JMS099.30 | 6/14/1990 | S | 1 | 24.69 | 7.37 | 8.21 | | | 0 | 1 |
| 2-JMS099.30 | 6/14/1990 | M | 3 | 24.33 | | 7.97 | | | 0 | |
| 2-JMS099.30 | 6/14/1990 | M | 5 | 24.24 | | 7.88 | | | 0 | |
| 2-JMS099.30 | 6/14/1990 | M | 7 | 24.22 | | 7.91 | | | 0 | |
| 2-JMS099.30 | 6/14/1990 | M | 9 | 24.24 | | 7.9 | | | 0 | |
| 2-JMS099.30 | 6/14/1990 | B | 11 | 24.25 | 7.39 | 7.87 | | | 0 | |
| 2-JMS099.30 | 6/27/1990 | S | 1 | 28 | 7.25 | 6.9 | | | 0 | |
| 2-JMS099.30 | 6/27/1990 | M | 3 | 27.74 | | 6.7 | | | 0 | |
| 2-JMS099.30 | 6/27/1990 | M | 5 | 27.73 | | 6.67 | | | 0 | |
| 2-JMS099.30 | 6/27/1990 | M | 7 | 27.68 | | 6.66 | | | 0 | |
| 2-JMS099.30 | 6/27/1990 | M | 9 | 27.66 | | 6.64 | | | 0 | |
| 2-JMS099.30 | 6/27/1990 | B | 11 | 27.66 | 7.3 | 6.61 | | | 0 | |
| 2-JMS099.30 | 7/10/1990 | S | 1 | 29.95 | 7.27 | 7.39 | | | 0 | 0.7 |
| 2-JMS099.30 | 7/10/1990 | M | 3 | 29.65 | | 6.75 | | | 0 | |
| 2-JMS099.30 | 7/10/1990 | M | 5 | 29.22 | | 6.39 | | | 0 | |
| 2-JMS099.30 | 7/10/1990 | M | 7 | 29.2 | | 6.38 | | | 0 | |
| 2-JMS099.30 | 7/10/1990 | M | 9 | 29.12 | | 6.41 | | | 0 | |
| 2-JMS099.30 | 7/10/1990 | B | 11 | 29.12 | 7.38 | 6.36 | | | 0 | |
| 2-JMS099.30 | 7/24/1990 | S | 1 | 30.21 | 7.32 | 7.5 | | | 0 | 1.2 |
| 2-JMS099.30 | 7/24/1990 | M | 3 | 30.06 | | 7.25 | | | 0 | |
| 2-JMS099.30 | 7/24/1990 | M | 5 | 30.07 | | 7.33 | | | 0 | |
| 2-JMS099.30 | 7/24/1990 | M | 7 | 30.05 | | 7.27 | | | 0 | |
| 2-JMS099.30 | 7/24/1990 | M | 9 | 30.03 | | 7.02 | | | 0 | |
| 2-JMS099.30 | 7/24/1990 | B | 10 | 29.91 | 7.22 | 6.96 | | | 0 | |
| 2-JMS099.30 | 8/7/1990 | S | 1 | 27.8 | 6.81 | 6.42 | | | 0 | 0.8 |
| 2-JMS099.30 | 8/7/1990 | M | 3 | 27.69 | | 6.09 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 8/7/1990 | M | 5 | 27.54 | | 6 | | | 0 | |
| 2-JMS099.30 | 8/7/1990 | M | 7 | 27.46 | | 6.08 | | | 0 | |
| 2-JMS099.30 | 8/7/1990 | M | 9 | 27.4 | | 6.14 | | | 0 | |
| 2-JMS099.30 | 8/7/1990 | B | 11 | 27.42 | 6.95 | 6.46 | | | 0 | |
| 2-JMS099.30 | 8/23/1990 | S | 1 | 27.47 | 6.97 | 5.79 | | | 0 | 1.1 |
| 2-JMS099.30 | 8/23/1990 | M | 3 | 27.23 | | 5.8 | | | 0 | |
| 2-JMS099.30 | 8/23/1990 | M | 5 | 27.01 | | 5.72 | | | 0 | |
| 2-JMS099.30 | 8/23/1990 | M | 7 | 26.79 | | 5.8 | | | 0 | |
| 2-JMS099.30 | 8/23/1990 | M | 9 | 26.75 | | 5.92 | | | 0 | |
| 2-JMS099.30 | 8/23/1990 | M | 11 | 26.71 | | 6.07 | | | 0 | |
| 2-JMS099.30 | 8/23/1990 | B | 12 | 26.73 | 7.03 | 6.26 | | | 0 | |
| 2-JMS099.30 | 9/6/1990 | S | 1 | 27.96 | 7.12 | 7.08 | | | 0 | 1.4 |
| 2-JMS099.30 | 9/6/1990 | M | 3 | 27.86 | | 6.79 | | | 0 | |
| 2-JMS099.30 | 9/6/1990 | M | 5 | 27.79 | | 6.73 | | | 0 | |
| 2-JMS099.30 | 9/6/1990 | M | 7 | 27.82 | | 6.78 | | | 0 | |
| 2-JMS099.30 | 9/6/1990 | M | 9 | 27.8 | | 6.73 | | | 0 | |
| 2-JMS099.30 | 9/6/1990 | B | 11 | 27.78 | 7.16 | 6.72 | | | 0 | |
| 2-JMS099.30 | 9/24/1990 | S | 1 | 22.25 | 7.4 | 8.86 | | | 0 | 1.3 |
| 2-JMS099.30 | 9/24/1990 | M | 3 | 21.9 | | 7.92 | | | 0 | |
| 2-JMS099.30 | 9/24/1990 | M | 5 | 21.77 | | 7.73 | | | 0 | |
| 2-JMS099.30 | 9/24/1990 | M | 7 | 21.76 | | 7.71 | | | 0 | |
| 2-JMS099.30 | 9/24/1990 | M | 9 | 21.76 | | 7.66 | | | 0 | |
| 2-JMS099.30 | 9/24/1990 | B | 11 | 21.74 | | 7.65 | | | 0 | |
| 2-JMS099.30 | 10/9/1990 | S | 1 | 23.06 | 7.08 | 7.79 | | | 0 | 1.3 |
| 2-JMS099.30 | 10/9/1990 | M | 3 | 22.8 | | 7.35 | | | 0 | |
| 2-JMS099.30 | 10/9/1990 | M | 5 | 22.45 | | 7.14 | | | 0 | |
| 2-JMS099.30 | 10/9/1990 | M | 7 | 22.45 | | 7.09 | | | 0 | |
| 2-JMS099.30 | 10/9/1990 | M | 9 | 22.46 | | 7.11 | | | 0 | |
| 2-JMS099.30 | 10/9/1990 | B | 11 | 22.48 | 7.24 | 7.08 | | | 0 | |
| 2-JMS099.30 | 10/25/1990 | S | 1 | 15.94 | 7.27 | 9.2 | | | 0 | 0.1 |
| 2-JMS099.30 | 10/25/1990 | M | 3 | 15.94 | | 9.21 | | | 0 | |
| 2-JMS099.30 | 10/25/1990 | M | 5 | 15.94 | | 9.23 | | | 0 | |
| 2-JMS099.30 | 10/25/1990 | M | 7 | 15.94 | | 9.19 | | | 0 | |
| 2-JMS099.30 | 10/25/1990 | M | 9 | 15.95 | | 9.15 | | | 0 | |
| 2-JMS099.30 | 10/25/1990 | B | 11 | 15.95 | 7.29 | 9.11 | | | 0 | |
| 2-JMS099.30 | 11/7/1990 | S | 1 | 14.88 | 7.1 | 9.42 | | | 0 | 1.1 |
| 2-JMS099.30 | 11/7/1990 | M | 3 | 14.86 | | 9.43 | | | 0 | |
| 2-JMS099.30 | 11/7/1990 | M | 5 | 14.77 | | 9.41 | | | 0 | |
| 2-JMS099.30 | 11/7/1990 | M | 7 | 14.77 | | 9.42 | | | 0 | |
| 2-JMS099.30 | 11/7/1990 | M | 9 | 14.8 | | 9.4 | | | 0 | |
| 2-JMS099.30 | 11/7/1990 | B | 11 | 14.8 | 7.1 | 9.45 | | | 0 | |
| 2-JMS099.30 | 12/12/1990 | S | 1 | 6.57 | 7.04 | 12.85 | | | 0 | 2 |
| 2-JMS099.30 | 12/12/1990 | M | 3 | 6.57 | | 12.86 | | | 0 | |
| 2-JMS099.30 | 12/12/1990 | M | 5 | 6.56 | | 12.85 | | | 0 | |
| 2-JMS099.30 | 12/12/1990 | M | 7 | 6.56 | | 13.1 | | | 0 | |
| 2-JMS099.30 | 12/12/1990 | M | 9 | 6.53 | | 13.06 | | | 0 | |
| 2-JMS099.30 | 12/12/1990 | B | 10 | 6.56 | 7 | 13.1 | | | 0 | |
| 2-JMS099.30 | 1/14/1991 | S | 1 | 6.35 | 7.14 | 11.81 | | | 0 | 0.2 |
| 2-JMS099.30 | 1/14/1991 | M | 3 | 6.35 | | 12.17 | | | 0 | |
| 2-JMS099.30 | 1/14/1991 | B | 10 | 6.36 | 7.2 | 12.12 | | | 0 | |
| 2-JMS099.30 | 2/25/1991 | S | 1 | 7.36 | 7.25 | 12.21 | | | 0 | 1.1 |
| 2-JMS099.30 | 2/25/1991 | M | 3 | 7.32 | | 12.29 | | | 0 | |
| 2-JMS099.30 | 2/25/1991 | M | 5 | 7.33 | | 12.3 | | | 0 | |
| 2-JMS099.30 | 2/25/1991 | M | 7 | 7.34 | | 12.36 | | | 0 | |
| 2-JMS099.30 | 2/25/1991 | M | 9 | 7.33 | | 12.47 | | | 0 | |
| 2-JMS099.30 | 2/25/1991 | B | 11 | 7.36 | 7.24 | 12.57 | | | 0 | |
| 2-JMS099.30 | 3/6/1991 | S | 1 | 10.05 | 7.11 | 11.09 | | | 0 | 0.1 |
| 2-JMS099.30 | 3/6/1991 | M | 3 | 10.06 | | 11.09 | | | 0 | |
| 2-JMS099.30 | 3/6/1991 | M | 5 | 10.06 | | 11.08 | | | 0 | |
| 2-JMS099.30 | 3/6/1991 | M | 7 | 10.07 | | 11.17 | | | 0 | |
| 2-JMS099.30 | 3/6/1991 | M | 9 | 10.08 | | 11.25 | | | 0 | |
| 2-JMS099.30 | 3/6/1991 | B | 11 | 10.08 | 7.1 | 11.43 | | | 0 | |
| 2-JMS099.30 | 3/20/1991 | S | 1 | 10.19 | 6.94 | 10.88 | | | 0 | 0.5 |
| 2-JMS099.30 | 3/20/1991 | M | 3 | 10.19 | | 10.89 | | | 0 | |
| 2-JMS099.30 | 3/20/1991 | M | 5 | 10.15 | | 10.91 | | | 0 | |
| 2-JMS099.30 | 3/20/1991 | M | 7 | 10.16 | | 10.89 | | | 0 | |
| 2-JMS099.30 | 3/20/1991 | M | 9 | 10.17 | | 10.89 | | | 0 | |
| 2-JMS099.30 | 3/20/1991 | B | 10 | 10.18 | 6.95 | 10.88 | | | 0 | |
| 2-JMS099.30 | 4/3/1991 | S | 1 | 11.47 | 6.86 | 11.17 | | | 0 | 0.4 |
| 2-JMS099.30 | 4/3/1991 | M | 3 | 11.46 | | 11.18 | | | 0 | |
| 2-JMS099.30 | 4/3/1991 | M | 5 | 11.46 | | 11.24 | | | 0 | |
| 2-JMS099.30 | 4/3/1991 | M | 7 | 11.48 | | 11.27 | | | 0 | |
| 2-JMS099.30 | 4/3/1991 | M | 9 | 11.48 | | 11.33 | | | 0 | |
| 2-JMS099.30 | 4/3/1991 | B | 10 | 11.48 | 6.84 | 11.38 | | | 0 | |
| 2-JMS099.30 | 4/23/1991 | S | 1 | 14.06 | 6.99 | 10.13 | | | 0 | 1.3 |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 4/23/1991 | M | 3 | 14 | | 10.19 | | | 0 | |
| 2-JMS099.30 | 4/23/1991 | M | 5 | 13.9 | | 10.2 | | | 0 | |
| 2-JMS099.30 | 4/23/1991 | M | 7 | 13.9 | | 10.25 | | | 0 | |
| 2-JMS099.30 | 4/23/1991 | M | 9 | 13.91 | | 10.36 | | | 0 | |
| 2-JMS099.30 | 4/23/1991 | B | 10 | 13.91 | 6.98 | 10.38 | | | 0 | |
| 2-JMS099.30 | 5/2/1991 | S | 1 | 21.79 | 7.29 | 8.38 | | | 0 | 1.5 |
| 2-JMS099.30 | 5/2/1991 | M | 3 | 21.79 | | 8.36 | | | 0 | |
| 2-JMS099.30 | 5/2/1991 | M | 5 | 21.78 | | 8.39 | | | 0 | |
| 2-JMS099.30 | 5/2/1991 | M | 7 | 21.78 | | 8.42 | | | 0 | |
| 2-JMS099.30 | 5/2/1991 | M | 9 | 21.79 | | 8.44 | | | 0 | |
| 2-JMS099.30 | 5/2/1991 | B | 11 | 21.82 | 7.14 | 8.51 | | | 0 | |
| 2-JMS099.30 | 5/16/1991 | S | 1 | 25.7 | 7.21 | 6.97 | | | 0 | |
| 2-JMS099.30 | 5/16/1991 | M | 3 | 25.52 | | 7 | | | 0 | |
| 2-JMS099.30 | 5/16/1991 | M | 5 | 25.41 | | 7.06 | | | 0 | |
| 2-JMS099.30 | 5/16/1991 | M | 7 | 25.41 | | 7.01 | | | 0 | |
| 2-JMS099.30 | 5/16/1991 | M | 9 | 25.33 | | 7.01 | | | 0 | |
| 2-JMS099.30 | 5/16/1991 | B | 11 | 25.3 | 7.27 | 7.02 | | | 0 | |
| 2-JMS099.30 | 6/13/1991 | S | 1 | 26.83 | 7.29 | 7.31 | | | 0 | 1 |
| 2-JMS099.30 | 6/13/1991 | M | 3 | 26.81 | | 7.17 | | | 0 | |
| 2-JMS099.30 | 6/13/1991 | M | 5 | 26.8 | | 7.14 | | | 0 | |
| 2-JMS099.30 | 6/13/1991 | M | 7 | 26.8 | | 7.13 | | | 0 | |
| 2-JMS099.30 | 6/13/1991 | B | 8 | 26.78 | 7.27 | 7.1 | | | 0 | |
| 2-JMS099.30 | 6/27/1991 | S | 1 | 25.94 | 7.06 | 7.13 | | | 0 | 1 |
| 2-JMS099.30 | 6/27/1991 | M | 3 | 25.22 | | 7.02 | | | 0 | |
| 2-JMS099.30 | 6/27/1991 | M | 5 | 25.13 | | 7.04 | | | 0 | |
| 2-JMS099.30 | 6/27/1991 | M | 7 | 25.06 | | 7.07 | | | 0 | |
| 2-JMS099.30 | 6/27/1991 | B | 9 | 24.94 | 7.13 | 7.07 | | | 0 | |
| 2-JMS099.30 | 7/16/1991 | S | 1 | 28.78 | 7.14 | 6.3 | | | 0 | 0.7 |
| 2-JMS099.30 | 7/16/1991 | M | 3 | 28.57 | | 6.35 | | | 0 | |
| 2-JMS099.30 | 7/16/1991 | M | 5 | 28.52 | | 6.31 | | | 0 | |
| 2-JMS099.30 | 7/16/1991 | M | 7 | 28.66 | | 6.34 | | | 0 | |
| 2-JMS099.30 | 7/16/1991 | M | 9 | 28.32 | | 6.21 | | | 0 | |
| 2-JMS099.30 | 7/16/1991 | B | 10 | 28.33 | 7.25 | 6.24 | | | 0 | |
| 2-JMS099.30 | 7/30/1991 | S | 1 | 24.61 | 6.73 | 7.11 | | | 0 | 0.4 |
| 2-JMS099.30 | 7/30/1991 | M | 3 | 24.57 | | 7.11 | | | 0 | |
| 2-JMS099.30 | 7/30/1991 | M | 5 | 24.56 | | 7.13 | | | 0 | |
| 2-JMS099.30 | 7/30/1991 | M | 7 | 24.56 | | 7.17 | | | 0 | |
| 2-JMS099.30 | 7/30/1991 | M | 9 | 24.56 | | 7.23 | | | 0 | |
| 2-JMS099.30 | 7/30/1991 | B | 10 | 24.56 | 6.79 | 7.38 | | | 0 | |
| 2-JMS099.30 | 8/13/1991 | S | 1 | 26.32 | 6.74 | 7.59 | | | 0 | 0.6 |
| 2-JMS099.30 | 8/13/1991 | M | 3 | 26.05 | | 7.61 | | | 0 | |
| 2-JMS099.30 | 8/13/1991 | M | 5 | 26.02 | | 7.66 | | | 0 | |
| 2-JMS099.30 | 8/13/1991 | M | 7 | 26.04 | | 7.68 | | | 0 | |
| 2-JMS099.30 | 8/13/1991 | M | 9 | 26.05 | | 7.72 | | | 0 | |
| 2-JMS099.30 | 8/13/1991 | B | 10 | 26.07 | 6.82 | 7.78 | | | 0 | |
| 2-JMS099.30 | 8/27/1991 | S | 1 | 28.16 | 7.07 | 6.38 | | | 0 | 1.6 |
| 2-JMS099.30 | 8/27/1991 | M | 3 | 27.89 | | 6.21 | | | 0 | |
| 2-JMS099.30 | 8/27/1991 | M | 5 | 27.69 | | 6.19 | | | 0 | |
| 2-JMS099.30 | 8/27/1991 | M | 7 | 27.73 | | 6.22 | | | 0 | |
| 2-JMS099.30 | 8/27/1991 | M | 9 | 27.68 | | 6.23 | | | 0 | |
| 2-JMS099.30 | 8/27/1991 | B | 11 | 27.57 | 6.94 | 6.46 | | | 0 | |
| 2-JMS099.30 | 9/12/1991 | S | 1 | 27.4 | 7.4 | 8.64 | | | 0 | 1 |
| 2-JMS099.30 | 9/12/1991 | M | 3 | 27.2 | | 8.21 | | | 0 | |
| 2-JMS099.30 | 9/12/1991 | M | 5 | 27.22 | | 8.26 | | | 0 | |
| 2-JMS099.30 | 9/12/1991 | M | 7 | 27.12 | | 8.1 | | | 0 | |
| 2-JMS099.30 | 9/12/1991 | M | 9 | 27.13 | | 8.23 | | | 0 | |
| 2-JMS099.30 | 9/12/1991 | B | 10 | 27.14 | | 8.12 | | | 0 | |
| 2-JMS099.30 | 10/1/1991 | S | 1 | 22.11 | 7.13 | 7.73 | | | 0 | 1 |
| 2-JMS099.30 | 10/1/1991 | M | 3 | 21.86 | | 7.38 | | | 0 | |
| 2-JMS099.30 | 10/1/1991 | M | 5 | 21.72 | | 7.35 | | | 0 | |
| 2-JMS099.30 | 10/1/1991 | M | 7 | 21.67 | | 7.3 | | | 0 | |
| 2-JMS099.30 | 10/1/1991 | B | 9 | 21.69 | 7.21 | 7.3 | | | 0 | |
| 2-JMS099.30 | 10/10/1991 | S | 1 | 21 | 7.22 | 7.34 | | | 0 | 1.1 |
| 2-JMS099.30 | 10/10/1991 | M | 3 | 20.92 | | 7.37 | | | 0 | |
| 2-JMS099.30 | 10/10/1991 | M | 5 | 20.8 | | 7.73 | | | 0 | |
| 2-JMS099.30 | 10/10/1991 | M | 7 | 20.72 | | 7.96 | | | 0 | |
| 2-JMS099.30 | 10/10/1991 | M | 9 | 20.69 | | 7.86 | | | 0 | |
| 2-JMS099.30 | 10/10/1991 | B | 11 | 20.7 | 7.21 | 8.13 | | | 0 | |
| 2-JMS099.30 | 10/28/1991 | S | 1 | 10 | 6.94 | 8 | | | 0 | 1.4 |
| 2-JMS099.30 | 10/28/1991 | M | 3 | 18.2 | | 8.05 | | | 0 | |
| 2-JMS099.30 | 10/28/1991 | M | 5 | 18.19 | | 8.09 | | | 0 | |
| 2-JMS099.30 | 10/28/1991 | M | 7 | 18.19 | | 8.14 | | | 0 | |
| 2-JMS099.30 | 10/28/1991 | M | 9 | 18.2 | | 8.22 | | | 0 | |
| 2-JMS099.30 | 10/28/1991 | B | 11 | 18.17 | 7.02 | 8.29 | | | 0 | |
| 2-JMS099.30 | 11/18/1991 | S | 1 | 9.9 | 7.34 | 10.52 | | | 0 | 1.4 |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 11/18/1991 | M | 3 | 9.72 | | 10.78 | | | 0 | |
| 2-JMS099.30 | 11/18/1991 | M | 5 | 9.67 | | 10.88 | | | 0 | |
| 2-JMS099.30 | 11/18/1991 | M | 7 | 9.64 | | 10.95 | | | 0 | |
| 2-JMS099.30 | 11/18/1991 | M | 9 | 9.64 | | 11.11 | | | 0 | |
| 2-JMS099.30 | 11/18/1991 | B | 10 | 9.64 | 7.55 | 11.45 | | | 0 | |
| 2-JMS099.30 | 12/11/1991 | S | 1 | 9.91 | 7.12 | 10.41 | | | 0 | 0.7 |
| 2-JMS099.30 | 12/11/1991 | M | 3 | 9.86 | | 10.4 | | | 0 | |
| 2-JMS099.30 | 12/11/1991 | M | 5 | 9.81 | | 10.38 | | | 0 | |
| 2-JMS099.30 | 12/11/1991 | M | 7 | 9.81 | | 10.81 | | | 0 | |
| 2-JMS099.30 | 12/11/1991 | M | 9 | 9.81 | | 10.77 | | | 0 | |
| 2-JMS099.30 | 12/11/1991 | B | 11 | 9.81 | 7.26 | 10.77 | | | 0 | |
| 2-JMS099.30 | 1/9/1992 | S | 1 | 7 | 7.05 | 13.29 | | | 0 | 0.4 |
| 2-JMS099.30 | 1/9/1992 | M | 3 | 7 | | 13.19 | | | 0 | |
| 2-JMS099.30 | 1/9/1992 | M | 5 | 7 | | 13.3 | | | 0 | |
| 2-JMS099.30 | 1/9/1992 | M | 7 | 7 | | 13.51 | | | 0 | |
| 2-JMS099.30 | 1/9/1992 | M | 9 | 6.98 | | 13.52 | | | 0 | |
| 2-JMS099.30 | 1/9/1992 | B | 11 | 7 | 7.11 | 13.41 | | | 0 | |
| 2-JMS099.30 | 2/10/1992 | S | 1 | 5.27 | 7.25 | 12.43 | | | 0 | 1.9 |
| 2-JMS099.30 | 2/10/1992 | M | 3 | 5.26 | | 12.43 | | | 0 | |
| 2-JMS099.30 | 2/10/1992 | M | 5 | 5.26 | | 12.44 | | | 0 | |
| 2-JMS099.30 | 2/10/1992 | M | 7 | 5.26 | | 12.44 | | | 0 | |
| 2-JMS099.30 | 2/10/1992 | M | 9 | 5.26 | | 12.37 | | | 0 | |
| 2-JMS099.30 | 2/10/1992 | B | 11 | 5.26 | 7.05 | 12.37 | | | 0 | |
| 2-JMS099.30 | 3/24/1992 | S | 1 | 8.74 | 7.17 | 11.4 | | | 0 | 1.1 |
| 2-JMS099.30 | 3/24/1992 | M | 3 | 8.72 | | 12.25 | | | 0 | |
| 2-JMS099.30 | 3/24/1992 | M | 5 | 8.68 | | 12.25 | | | 0 | |
| 2-JMS099.30 | 3/24/1992 | M | 7 | 8.68 | | 12.19 | | | 0 | |
| 2-JMS099.30 | 3/24/1992 | M | 9 | 8.68 | | 12.19 | | | 0 | |
| 2-JMS099.30 | 3/24/1992 | B | 10 | 8.68 | 7.14 | 12.14 | | | 0 | |
| 2-JMS099.30 | 4/7/1992 | S | 1 | 10.76 | 7 | 11.16 | | | 0 | 1.5 |
| 2-JMS099.30 | 4/7/1992 | M | 3 | 10.72 | | 11.13 | | | 0 | |
| 2-JMS099.30 | 4/7/1992 | M | 5 | 10.74 | | 11.25 | | | 0 | |
| 2-JMS099.30 | 4/7/1992 | M | 7 | 10.74 | | 11.36 | | | 0 | |
| 2-JMS099.30 | 4/7/1992 | M | 9 | 10.76 | | 11.84 | | | 0 | |
| 2-JMS099.30 | 4/7/1992 | B | 11 | 10.81 | 6.85 | 11.8 | | | 0 | |
| 2-JMS099.30 | 4/21/1992 | S | 1 | 19.78 | 7.48 | 8 | | | 0 | 1.3 |
| 2-JMS099.30 | 4/21/1992 | M | 3 | 19.77 | | 7.98 | | | 0 | |
| 2-JMS099.30 | 4/21/1992 | M | 5 | 19.77 | | 7.91 | | | 0 | |
| 2-JMS099.30 | 4/21/1992 | M | 7 | 19.74 | | 7.95 | | | 0 | |
| 2-JMS099.30 | 4/21/1992 | M | 9 | 19.73 | | 7.88 | | | 0 | |
| 2-JMS099.30 | 4/21/1992 | B | 11 | 19.75 | 7.43 | 7.95 | | | 0 | |
| 2-JMS099.30 | 5/6/1992 | S | 1 | 18.03 | 7.39 | 8.71 | | | 0 | 1.5 |
| 2-JMS099.30 | 5/6/1992 | M | 3 | 18.01 | | 8.72 | | | 0 | |
| 2-JMS099.30 | 5/6/1992 | M | 5 | 17.99 | | 8.72 | | | 0 | |
| 2-JMS099.30 | 5/6/1992 | M | 7 | 17.98 | | 8.72 | | | 0 | |
| 2-JMS099.30 | 5/6/1992 | M | 9 | 17.97 | | 8.73 | | | 0 | |
| 2-JMS099.30 | 5/6/1992 | M | 11 | 17.96 | | 8.73 | | | 0 | |
| 2-JMS099.30 | 5/6/1992 | B | 12 | 17.95 | 7.22 | 8.74 | | | 0 | |
| 2-JMS099.30 | 5/27/1992 | S | 1 | 19.39 | 7.33 | 8.39 | | | 0 | 1.6 |
| 2-JMS099.30 | 5/27/1992 | M | 3 | 19.3 | | 8.35 | | | 0 | |
| 2-JMS099.30 | 5/27/1992 | M | 5 | 19.27 | | 8.37 | | | 0 | |
| 2-JMS099.30 | 5/27/1992 | M | 7 | 19.26 | | 8.37 | | | 0 | |
| 2-JMS099.30 | 5/27/1992 | M | 9 | 19.26 | | 8.37 | | | 0 | |
| 2-JMS099.30 | 5/27/1992 | M | 11 | 19.27 | | 8.36 | | | 0 | |
| 2-JMS099.30 | 5/27/1992 | B | 12 | 19.29 | 7.19 | 8.39 | | | 0 | |
| 2-JMS099.30 | 5/27/1992 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 6/18/1992 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 6/18/1992 | S | 1 | 24.34 | 7.73 | 8.16 | | | 0 | 1.2 |
| 2-JMS099.30 | 6/18/1992 | M | 3 | 24.05 | | 8.06 | | | 0 | |
| 2-JMS099.30 | 6/18/1992 | M | 5 | 23.94 | | 8.04 | | | 0 | |
| 2-JMS099.30 | 6/18/1992 | M | 7 | 23.86 | | 8.01 | | | 0 | |
| 2-JMS099.30 | 6/18/1992 | M | 9 | 23.83 | | 7.99 | | | 0 | |
| 2-JMS099.30 | 6/18/1992 | B | 11 | 23.77 | 7.54 | 7.98 | | | 0 | |
| 2-JMS099.30 | 7/6/1992 | S | 1 | 27.95 | 7.66 | 7.28 | | | 0 | 1.3 |
| 2-JMS099.30 | 7/6/1992 | M | 3 | 27.91 | | 7.29 | | | 0 | |
| 2-JMS099.30 | 7/6/1992 | M | 5 | 27.87 | | 7.31 | | | 0 | |
| 2-JMS099.30 | 7/6/1992 | M | 7 | 27.85 | | 7.3 | | | 0 | |
| 2-JMS099.30 | 7/6/1992 | M | 9 | 27.85 | | 7.32 | | | 0 | |
| 2-JMS099.30 | 7/6/1992 | B | 11 | 27.84 | 7.5 | 7.34 | | | 0 | |
| 2-JMS099.30 | 7/20/1992 | S | 1 | 30.58 | 7.2 | 6.37 | | | 0 | 1.2 |
| 2-JMS099.30 | 7/20/1992 | M | 3 | 30.4 | | 6.15 | | | 0 | |
| 2-JMS099.30 | 7/20/1992 | M | 5 | 30.25 | | 5.89 | | | 0 | |
| 2-JMS099.30 | 7/20/1992 | M | 7 | 30.21 | | 6.22 | | | 0 | |
| 2-JMS099.30 | 7/20/1992 | B | 9 | 30.22 | 7.1 | 6.25 | | | 0 | |
| 2-JMS099.30 | 7/20/1992 | S | 0.3 | 30.5 | 7.2 | 6.3 | | | | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 9/1/1992 | S | 1 | 26.74 | 7.45 | 7.84 | | | 0 | 1.2 |
| 2-JMS099.30 | 9/1/1992 | M | 3 | 26.58 | | 7.57 | | | 0 | |
| 2-JMS099.30 | 9/1/1992 | M | 5 | 26.39 | | 7.09 | | | 0 | |
| 2-JMS099.30 | 9/1/1992 | M | 7 | 26.39 | | 7.13 | | | 0 | |
| 2-JMS099.30 | 9/1/1992 | M | 9 | 26.39 | | 7.13 | | | 0 | |
| 2-JMS099.30 | 9/1/1992 | B | 10 | 26.39 | 7.28 | 7.17 | | | 0 | |
| 2-JMS099.30 | 9/1/1992 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 10/8/1992 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 10/8/1992 | M | 1 | 18.21 | 7.29 | 8.39 | | | 0 | 1.4 |
| 2-JMS099.30 | 10/8/1992 | M | 3 | 17.94 | | 8.43 | | | 0 | |
| 2-JMS099.30 | 10/8/1992 | M | 5 | 17.84 | | 8.49 | | | 0 | |
| 2-JMS099.30 | 10/8/1992 | M | 7 | 17.69 | | 8.5 | | | 0 | |
| 2-JMS099.30 | 10/8/1992 | M | 9 | 17.69 | | 8.66 | | | 0 | |
| 2-JMS099.30 | 10/8/1992 | M | 11 | 17.65 | | 8.73 | | | 0 | |
| 2-JMS099.30 | 10/8/1992 | B | 12 | 17.66 | 7.29 | 8.87 | | | 0 | |
| 2-JMS099.30 | 11/2/1992 | S | 1 | 14.91 | 7.15 | 9.22 | | | 0 | 1.6 |
| 2-JMS099.30 | 11/2/1992 | M | 3 | 14.9 | | 9.22 | | | 0 | |
| 2-JMS099.30 | 11/2/1992 | M | 5 | 14.9 | | 9.22 | | | 0 | |
| 2-JMS099.30 | 11/2/1992 | M | 7 | 14.9 | | 9.27 | | | 0 | |
| 2-JMS099.30 | 11/2/1992 | M | 9 | 14.9 | | 9.27 | | | 0 | |
| 2-JMS099.30 | 11/2/1992 | B | 11 | 14.91 | 7.08 | 9.35 | | | 0 | |
| 2-JMS099.30 | 11/17/1992 | S | 1 | 9.43 | 7.48 | 11.35 | | | 0 | 0.5 |
| 2-JMS099.30 | 11/17/1992 | M | 3 | 9.4 | | 11.37 | | | 0 | |
| 2-JMS099.30 | 11/17/1992 | M | 5 | 9.38 | | 11.33 | | | 0 | |
| 2-JMS099.30 | 11/17/1992 | M | 7 | 9.36 | | 11.35 | | | 0 | |
| 2-JMS099.30 | 11/17/1992 | M | 9 | 9.31 | | 11.37 | | | 0 | |
| 2-JMS099.30 | 11/17/1992 | B | 11 | 9.35 | 7.45 | 11.42 | | | 0 | |
| 2-JMS099.30 | 11/17/1992 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 12/15/1992 | S | 1 | 5.18 | 7.26 | 12.78 | | | 0 | 0.3 |
| 2-JMS099.30 | 12/15/1992 | M | 3 | 5.18 | | 12.79 | | | 0 | |
| 2-JMS099.30 | 12/15/1992 | M | 5 | 5.18 | | 12.86 | | | 0 | |
| 2-JMS099.30 | 12/15/1992 | M | 7 | 5.19 | | 12.86 | | | 0 | |
| 2-JMS099.30 | 12/15/1992 | M | 9 | 5.18 | | 12.92 | | | 0 | |
| 2-JMS099.30 | 12/15/1992 | B | 11 | 5.19 | 7.19 | 12.95 | | | 0 | |
| 2-JMS099.30 | 12/15/1992 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 1/14/1993 | S | 1 | 6.62 | 7.49 | 12.06 | | | 0 | 0.8 |
| 2-JMS099.30 | 1/14/1993 | M | 3 | 6.62 | | 12.12 | | | 0 | |
| 2-JMS099.30 | 1/14/1993 | M | 5 | 6.62 | | 12.12 | | | 0 | |
| 2-JMS099.30 | 1/14/1993 | M | 7 | 6.62 | | 12.12 | | | 0 | |
| 2-JMS099.30 | 1/14/1993 | M | 9 | 6.62 | | 12.19 | | | 0 | |
| 2-JMS099.30 | 1/14/1993 | B | 11 | 6.63 | 7.47 | 12.37 | | | 0 | |
| 2-JMS099.30 | 1/14/1993 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 2/9/1993 | S | 1 | 5.14 | 7.43 | 13.27 | | | 0 | 1.9 |
| 2-JMS099.30 | 2/9/1993 | M | 3 | 5.07 | | 13.33 | | | 0 | |
| 2-JMS099.30 | 2/9/1993 | M | 5 | 5.06 | | 13.34 | | | 0 | |
| 2-JMS099.30 | 2/9/1993 | M | 7 | 5.05 | | 13.43 | | | 0 | |
| 2-JMS099.30 | 2/9/1993 | M | 9 | 5.02 | | 13.5 | | | 0 | |
| 2-JMS099.30 | 2/9/1993 | B | 10 | 5.02 | 7.29 | 13.6 | | | 0 | |
| 2-JMS099.30 | 2/9/1993 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 3/10/1993 | S | 1 | 7.68 | 7.21 | 11.85 | | | 0 | 0.4 |
| 2-JMS099.30 | 3/10/1993 | M | 3 | 7.67 | | 11.87 | | | 0 | |
| 2-JMS099.30 | 3/10/1993 | M | 5 | 7.66 | | 11.94 | | | 0 | |
| 2-JMS099.30 | 3/10/1993 | M | 7 | 7.67 | | 11.93 | | | 0 | |
| 2-JMS099.30 | 3/10/1993 | M | 9 | 7.69 | | 12.02 | | | 0 | |
| 2-JMS099.30 | 3/10/1993 | B | 11 | 7.7 | 6.9 | 12.2 | | | 0 | |
| 2-JMS099.30 | 4/8/1993 | S | 1 | 10.69 | 7.2 | 11.04 | | | 0 | 0.9 |
| 2-JMS099.30 | 4/8/1993 | M | 3 | 10.67 | | 11.04 | | | 0 | |
| 2-JMS099.30 | 4/8/1993 | M | 5 | 10.7 | | 11.03 | | | 0 | |
| 2-JMS099.30 | 4/8/1993 | M | 7 | 10.69 | | 11.04 | | | 0 | |
| 2-JMS099.30 | 4/8/1993 | M | 9 | 10.71 | | 11.13 | | | 0 | |
| 2-JMS099.30 | 4/8/1993 | B | 11 | 10.74 | 7.1 | 11.2 | | | 0 | |
| 2-JMS099.30 | 4/28/1993 | S | 1 | 16.1 | 7.32 | 9.65 | | | 0 | 1.1 |
| 2-JMS099.30 | 4/28/1993 | M | 3 | 16.05 | | 9.63 | | | 0 | |
| 2-JMS099.30 | 4/28/1993 | M | 5 | 15.92 | | 9.64 | | | 0 | |
| 2-JMS099.30 | 4/28/1993 | M | 7 | 15.94 | | 9.68 | | | 0 | |
| 2-JMS099.30 | 4/28/1993 | M | 9 | 15.97 | | 9.7 | | | 0 | |
| 2-JMS099.30 | 4/28/1993 | B | 11 | 15.97 | 7.25 | 9.82 | | | 0 | |
| 2-JMS099.30 | 5/6/1993 | S | 1 | 21.38 | 7.49 | 8.63 | | | 0 | 1.4 |
| 2-JMS099.30 | 5/6/1993 | M | 3 | 21.19 | | 8.59 | | | 0 | |
| 2-JMS099.30 | 5/6/1993 | M | 5 | 21.12 | | 8.59 | | | 0 | |
| 2-JMS099.30 | 5/6/1993 | M | 7 | 21.09 | | 8.86 | | | 0 | |
| 2-JMS099.30 | 5/6/1993 | M | 9 | 21.07 | | 8.86 | | | 0 | |
| 2-JMS099.30 | 5/6/1993 | B | 11 | 21.07 | 7.33 | 8.93 | | | 0 | |
| 2-JMS099.30 | 6/2/1993 | S | 1 | 23.9 | 7.28 | 7.63 | | | 0 | 1 |
| 2-JMS099.30 | 6/2/1993 | M | 3 | 23.91 | | 7.62 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 6/2/1993 | M | 5 | 23.83 | | 7.59 | | | 0 | |
| 2-JMS099.30 | 6/2/1993 | M | 7 | 23.73 | | 7.59 | | | 0 | |
| 2-JMS099.30 | 6/2/1993 | M | 9 | 23.58 | | 7.61 | | | 0 | |
| 2-JMS099.30 | 6/2/1993 | B | 11 | 23.52 | 7.18 | 7.66 | | | 0 | |
| 2-JMS099.30 | 6/2/1993 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 6/7/1993 | S | 1 | 24.43 | 7.24 | 7.88 | | | 0 | 1.2 |
| 2-JMS099.30 | 6/7/1993 | M | 3 | 24.24 | | 7.87 | | | 0 | |
| 2-JMS099.30 | 6/7/1993 | M | 5 | 23.98 | | 7.78 | | | 0 | |
| 2-JMS099.30 | 6/7/1993 | M | 7 | 23.89 | | 7.8 | | | 0 | |
| 2-JMS099.30 | 6/7/1993 | M | 9 | 23.86 | | 7.85 | | | 0 | |
| 2-JMS099.30 | 6/7/1993 | B | 10 | 23.83 | 7.11 | 7.91 | | | 0 | |
| 2-JMS099.30 | 6/22/1993 | S | 1 | 29.83 | 7.6 | 7.23 | | | 0 | 1.3 |
| 2-JMS099.30 | 6/22/1993 | M | 3 | 29.78 | | 7.26 | | | 0 | |
| 2-JMS099.30 | 6/22/1993 | M | 5 | 29.75 | | 7.25 | | | 0 | |
| 2-JMS099.30 | 6/22/1993 | M | 7 | 29.56 | | 7.18 | | | 0 | |
| 2-JMS099.30 | 6/22/1993 | M | 9 | 29.56 | | 7.15 | | | 0 | |
| 2-JMS099.30 | 6/22/1993 | B | 10 | 29.53 | 7.34 | 7.19 | | | 0 | |
| 2-JMS099.30 | 7/7/1993 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 7/7/1993 | S | 1 | 31.16 | 7.73 | 8.28 | | | 0 | 1.3 |
| 2-JMS099.30 | 7/7/1993 | M | 3 | 30.46 | | 6.6 | | | 0 | |
| 2-JMS099.30 | 7/7/1993 | M | 5 | 30.46 | | 6.3 | | | 0 | |
| 2-JMS099.30 | 7/7/1993 | M | 7 | 30.48 | | 6.34 | | | 0 | |
| 2-JMS099.30 | 7/7/1993 | M | 9 | 30.48 | | 6.41 | | | 0 | |
| 2-JMS099.30 | 7/7/1993 | B | 11 | 30.49 | 7.22 | 6.35 | | | 0 | |
| 2-JMS099.30 | 7/21/1993 | B | 1 | | | | | | | |
| 2-JMS099.30 | 7/21/1993 | S | 1 | 30.56 | 7.36 | 6.95 | | | 0 | 0.9 |
| 2-JMS099.30 | 7/21/1993 | M | 3 | 30.27 | | 6.4 | | | 0 | |
| 2-JMS099.30 | 7/21/1993 | M | 5 | 30.11 | | 6.25 | | | 0 | |
| 2-JMS099.30 | 7/21/1993 | M | 7 | 30.1 | | 6.38 | | | 0 | |
| 2-JMS099.30 | 7/21/1993 | M | 9 | 30.07 | | 6.33 | | | 0 | |
| 2-JMS099.30 | 7/21/1993 | M | 11 | 30.04 | 7.19 | 6.35 | | | 0 | |
| 2-JMS099.30 | 7/21/1993 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 8/4/1993 | S | 1 | 29.14 | 7.43 | 6.88 | | | 0 | 1.3 |
| 2-JMS099.30 | 8/4/1993 | M | 3 | 29.13 | | 6.85 | | | 0 | |
| 2-JMS099.30 | 8/4/1993 | M | 5 | 29.09 | | 6.79 | | | 0 | |
| 2-JMS099.30 | 8/4/1993 | M | 7 | 29.05 | | 6.74 | | | 0 | |
| 2-JMS099.30 | 8/4/1993 | M | 9 | 29.04 | | 6.73 | | | 0 | |
| 2-JMS099.30 | 8/4/1993 | B | 11 | 29.01 | 7.34 | 6.74 | | | 0 | |
| 2-JMS099.30 | 8/4/1993 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 8/18/1993 | S | 1 | 29.24 | 7.32 | 7.58 | | | | 1.1 |
| 2-JMS099.30 | 8/18/1993 | M | 3 | 29.15 | | 7.42 | | | | |
| 2-JMS099.30 | 8/18/1993 | M | 5 | 28.99 | | 7.27 | | | | |
| 2-JMS099.30 | 8/18/1993 | M | 7 | 28.82 | | 7.1 | | | | |
| 2-JMS099.30 | 8/18/1993 | M | 9 | 28.71 | | 6.94 | | | | |
| 2-JMS099.30 | 8/18/1993 | B | 11 | 28.67 | 7.09 | 6.8 | | | | |
| 2-JMS099.30 | 8/18/1993 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 8/18/1993 | B | 1 | | | | | | | |
| 2-JMS099.30 | 9/2/1993 | S | 1 | 31.44 | 7.64 | 7.55 | | | 0 | 1.1 |
| 2-JMS099.30 | 9/2/1993 | M | 3 | 30.11 | | 7.11 | | | 0 | |
| 2-JMS099.30 | 9/2/1993 | M | 5 | 30.86 | | 7.1 | | | 0 | |
| 2-JMS099.30 | 9/2/1993 | M | 7 | 30.62 | | 6.89 | | | 0 | |
| 2-JMS099.30 | 9/2/1993 | B | 9 | 30.54 | 7.23 | 6.63 | | | 0 | |
| 2-JMS099.30 | 9/20/1993 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 9/20/1993 | S | 1 | 25.84 | 7.64 | 6.9 | | | 0 | 1.4 |
| 2-JMS099.30 | 9/20/1993 | M | 3 | 25.52 | | 6.39 | | | 0 | |
| 2-JMS099.30 | 9/20/1993 | M | 5 | 25.48 | | 6.36 | | | 0 | |
| 2-JMS099.30 | 9/20/1993 | M | 7 | 25.49 | | 6.63 | | | 0 | |
| 2-JMS099.30 | 9/20/1993 | M | 9 | 25.46 | | 7.03 | | | 0 | |
| 2-JMS099.30 | 9/20/1993 | B | 11 | 25.44 | 7.42 | 6.69 | | | 0 | |
| 2-JMS099.30 | 10/5/1993 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 10/5/1993 | B | 1 | | | | | | | |
| 2-JMS099.30 | 10/5/1993 | M | 1 | 20.01 | 8.18 | 8.8 | | | 0 | 1.5 |
| 2-JMS099.30 | 10/5/1993 | M | 3 | 19.85 | | 8.72 | | | 0 | |
| 2-JMS099.30 | 10/5/1993 | M | 5 | 19.63 | | 8.62 | | | 0 | |
| 2-JMS099.30 | 10/5/1993 | M | 7 | 19.61 | | 8.63 | | | 0 | |
| 2-JMS099.30 | 10/5/1993 | M | 9 | 19.6 | | 8.67 | | | 0 | |
| 2-JMS099.30 | 10/5/1993 | M | 11 | 19.59 | 8.13 | 8.67 | | | 0 | |
| 2-JMS099.30 | 11/17/1993 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 11/17/1993 | B | 1 | | | | | | | |
| 2-JMS099.30 | 12/2/1993 | B | 0.3 | | | | | | | |
| 2-JMS099.30 | 12/2/1993 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 12/2/1993 | M | 1 | 8.3 | 6.96 | 11.63 | | | 0 | 0.3 |
| 2-JMS099.30 | 12/2/1993 | M | 3 | 8.27 | | 11.71 | | | 0 | |
| 2-JMS099.30 | 12/2/1993 | M | 5 | 8.2 | | 11.75 | | | 0 | |
| 2-JMS099.30 | 12/2/1993 | M | 7 | 8.18 | | 11.82 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 12/2/1993 | M | 9 | 8.22 | | 11.86 | | | 0 | |
| 2-JMS099.30 | 12/2/1993 | M | 11 | 8.21 | 6.78 | 11.9 | | | 0 | |
| 2-JMS099.30 | 2/17/1994 | S | 1 | 4.33 | 7.34 | 13.01 | | | 0 | 0.7 |
| 2-JMS099.30 | 2/17/1994 | M | 3 | 4.34 | | 12.99 | | | 0 | |
| 2-JMS099.30 | 2/17/1994 | M | 5 | 4.33 | | 12.98 | | | 0 | |
| 2-JMS099.30 | 2/17/1994 | M | 7 | 4.33 | | 12.93 | | | 0 | |
| 2-JMS099.30 | 2/17/1994 | M | 9 | 4.34 | | 12.89 | | | 0 | |
| 2-JMS099.30 | 2/17/1994 | B | 10 | 4.34 | 7.3 | 12.87 | | | 0 | |
| 2-JMS099.30 | 3/21/1994 | S | 1 | 9.49 | 7.54 | 11.1 | | | 0 | 1.4 |
| 2-JMS099.30 | 3/21/1994 | M | 3 | 9.45 | | 11.05 | | | 0 | |
| 2-JMS099.30 | 3/21/1994 | M | 5 | 9.45 | | 11.05 | | | 0 | |
| 2-JMS099.30 | 3/21/1994 | M | 7 | 9.44 | | 11.05 | | | 0 | |
| 2-JMS099.30 | 3/21/1994 | M | 9 | 9.44 | | 11.07 | | | 0 | |
| 2-JMS099.30 | 3/21/1994 | B | 10 | 9.44 | 7.52 | 11.1 | | | 0 | |
| 2-JMS099.30 | 4/14/1994 | S | 1 | 16.66 | 7.67 | 9.6 | | | 0 | 1.4 |
| 2-JMS099.30 | 4/14/1994 | M | 3 | 16.51 | | 9.58 | | | 0 | |
| 2-JMS099.30 | 4/14/1994 | M | 5 | 16.3 | | 9.59 | | | 0 | |
| 2-JMS099.30 | 4/14/1994 | M | 7 | 16.3 | | 9.65 | | | 0 | |
| 2-JMS099.30 | 4/14/1994 | M | 9 | 16.3 | | 9.73 | | | 0 | |
| 2-JMS099.30 | 4/14/1994 | B | 11 | 16.35 | 7.43 | 9.7 | | | 0 | |
| 2-JMS099.30 | 5/23/1994 | S | 1 | 19.49 | 8.94 | 10.21 | | | 0 | 0.8 |
| 2-JMS099.30 | 5/23/1994 | M | 3 | 19.15 | | 9.68 | | | 0 | |
| 2-JMS099.30 | 5/23/1994 | M | 5 | 19.16 | | 9.66 | | | 0 | |
| 2-JMS099.30 | 5/23/1994 | M | 7 | 19.23 | | 9.77 | | | 0 | |
| 2-JMS099.30 | 5/23/1994 | M | 9 | 19.1 | | 9.5 | | | 0 | |
| 2-JMS099.30 | 5/23/1994 | B | 11 | 19.08 | 8.72 | 9.52 | | | 0 | |
| 2-JMS099.30 | 6/9/1994 | S | 1 | 26.16 | 7.63 | 7.35 | | | 0 | 1 |
| 2-JMS099.30 | 6/9/1994 | M | 3 | 25.93 | | 6.93 | | | 0 | |
| 2-JMS099.30 | 6/9/1994 | M | 5 | 25.86 | | 6.41 | | | 0 | |
| 2-JMS099.30 | 6/9/1994 | M | 7 | 25.8 | | 6.24 | | | 0 | |
| 2-JMS099.30 | 6/9/1994 | M | 9 | 25.7 | | 6.11 | | | 0 | |
| 2-JMS099.30 | 6/9/1994 | M | 11 | 25.66 | | 6.09 | | | 0 | |
| 2-JMS099.30 | 6/9/1994 | B | 12 | 25.65 | 7.34 | 6.13 | | | 0 | |
| 2-JMS099.30 | 6/28/1994 | S | 0.3 | 29.55 | 8.34 | 9.36 | | | | |
| 2-JMS099.30 | 7/7/1994 | S | 1 | 31.85 | 7.83 | 8.36 | | | 0 | 1 |
| 2-JMS099.30 | 7/7/1994 | M | 3 | 30.89 | | 7.5 | | | 0 | |
| 2-JMS099.30 | 7/7/1994 | M | 5 | 30.54 | | 7.37 | | | 0 | |
| 2-JMS099.30 | 7/7/1994 | M | 7 | 30.04 | | 6.9 | | | 0 | |
| 2-JMS099.30 | 7/7/1994 | M | 9 | 29.86 | | 6.81 | | | 0 | |
| 2-JMS099.30 | 7/7/1994 | M | 11 | 29.86 | | 6.78 | | | 0 | |
| 2-JMS099.30 | 7/7/1994 | B | 12 | 29.84 | 7.33 | 6.76 | | | 0 | |
| 2-JMS099.30 | 7/14/1994 | S | 0.3 | 30.58 | 7.33 | 6.31 | | | | |
| 2-JMS099.30 | 7/28/1994 | S | 0.3 | 29.2 | 7.39 | 6.3 | | | | |
| 2-JMS099.30 | 8/11/1994 | S | 1 | 27.6 | 7.72 | 8.19 | | | 0 | 1.3 |
| 2-JMS099.30 | 8/11/1994 | M | 3 | 27.43 | | 7.98 | | | 0 | |
| 2-JMS099.30 | 8/11/1994 | M | 5 | 27.14 | | 7.68 | | | 0 | |
| 2-JMS099.30 | 8/11/1994 | M | 7 | 27.06 | | 7.58 | | | 0 | |
| 2-JMS099.30 | 8/11/1994 | M | 9 | 27.01 | | 7.58 | | | 0 | |
| 2-JMS099.30 | 8/11/1994 | B | 11 | 27 | 7.57 | 7.61 | | | 0 | |
| 2-JMS099.30 | 8/18/1994 | S | 0.3 | 26.47 | 7.47 | 7.12 | | | | |
| 2-JMS099.30 | 8/30/1994 | S | 0.3 | 27.67 | 7.77 | 7.9 | | | | |
| 2-JMS099.30 | 9/8/1994 | S | 12 | 24.17 | 7.93 | 8.25 | | | 0 | |
| 2-JMS099.30 | 9/8/1994 | S | 1 | 24.35 | 8.1 | 8.68 | | | 0 | 1.3 |
| 2-JMS099.30 | 9/8/1994 | M | 3 | 24.28 | | 8.33 | | | 0 | |
| 2-JMS099.30 | 9/8/1994 | M | 5 | 24.25 | | 8.28 | | | 0 | |
| 2-JMS099.30 | 9/8/1994 | M | 7 | 24.23 | | 8.28 | | | 0 | |
| 2-JMS099.30 | 9/8/1994 | M | 9 | 24.21 | | 8.25 | | | 0 | |
| 2-JMS099.30 | 9/8/1994 | B | 11 | 24.21 | | 8.25 | | | 0 | |
| 2-JMS099.30 | 9/13/1994 | S | 0.3 | 25.55 | 8.15 | 8.86 | | | | |
| 2-JMS099.30 | 9/26/1994 | S | 0.3 | 21.8 | 7.5 | 7.93 | | | | |
| 2-JMS099.30 | 10/12/1994 | S | 0.3 | 18.6 | 7.88 | 8.9 | | | | |
| 2-JMS099.30 | 10/17/1994 | S | 10 | 16.72 | 7.75 | 7.87 | | | | |
| 2-JMS099.30 | 10/17/1994 | S | 1 | 17.41 | 7.87 | 8.82 | | | | |
| 2-JMS099.30 | 10/17/1994 | M | 3 | 16.94 | | 8.71 | | | | |
| 2-JMS099.30 | 10/17/1994 | M | 5 | 16.95 | | 8.68 | | | | |
| 2-JMS099.30 | 10/17/1994 | M | 7 | 16.73 | | 8.47 | | | | |
| 2-JMS099.30 | 10/17/1994 | B | 9 | 16.73 | | 8.27 | | | | |
| 2-JMS099.30 | 10/25/1994 | S | 0.3 | 17.16 | 7.71 | 9.22 | | | | |
| 2-JMS099.30 | 11/30/1994 | S | 11 | 9.14 | 7.36 | 10.82 | | | 0 | |
| 2-JMS099.30 | 11/30/1994 | S | 1 | 9.3 | 7.38 | 10.88 | | | 0 | 1.3 |
| 2-JMS099.30 | 11/30/1994 | M | 3 | 9.24 | | 10.85 | | | 0 | |
| 2-JMS099.30 | 11/30/1994 | M | 5 | 9.19 | | 10.84 | | | 0 | |
| 2-JMS099.30 | 11/30/1994 | M | 7 | 9.17 | | 10.83 | | | 0 | |
| 2-JMS099.30 | 11/30/1994 | B | 9 | 9.12 | | 10.82 | | | 0 | |
| 2-JMS099.30 | 12/6/1994 | S | 10 | 9.12 | 7.55 | 10.51 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 12/6/1994 | S | 1 | 9.37 | 7.52 | 11.17 | | | 0 | 1.6 |
| 2-JMS099.30 | 12/6/1994 | M | 3 | 9.43 | | 11.15 | | | 0 | |
| 2-JMS099.30 | 12/6/1994 | M | 5 | 9.37 | | 11.23 | | | 0 | |
| 2-JMS099.30 | 12/6/1994 | M | 7 | 9.12 | | 11.28 | | | 0 | |
| 2-JMS099.30 | 12/6/1994 | B | 9 | 9.12 | | 10.61 | | | 0 | |
| 2-JMS099.30 | 1/25/1995 | S | 11 | 5.3 | 7.54 | 12.8 | | | 0 | |
| 2-JMS099.30 | 1/25/1995 | S | 1 | 5.25 | 7.6 | 12.73 | | | 0 | 0.8 |
| 2-JMS099.30 | 1/25/1995 | M | 3 | 5.26 | | 12.75 | | | 0 | |
| 2-JMS099.30 | 1/25/1995 | M | 5 | 5.27 | | 12.77 | | | 0 | |
| 2-JMS099.30 | 1/25/1995 | M | 7 | 5.26 | | 12.75 | | | 0 | |
| 2-JMS099.30 | 1/25/1995 | B | 9 | 5.27 | | 12.78 | | | 0 | |
| 2-JMS099.30 | 2/27/1995 | S | 11 | 7.89 | 7.65 | 11.84 | | | 0 | |
| 2-JMS099.30 | 2/27/1995 | S | 1 | 8.5 | 7.72 | 11.9 | | | 0 | 1.2 |
| 2-JMS099.30 | 2/27/1995 | M | 3 | 8.07 | | 11.9 | | | 0 | |
| 2-JMS099.30 | 2/27/1995 | M | 5 | 7.96 | | 11.89 | | | 0 | |
| 2-JMS099.30 | 2/27/1995 | M | 7 | 7.92 | | 11.89 | | | 0 | |
| 2-JMS099.30 | 2/27/1995 | B | 9 | 7.91 | | 11.88 | | | 0 | |
| 2-JMS099.30 | 3/23/1995 | S | 1 | 14.56 | 7.67 | 10.26 | | | 0 | 1.1 |
| 2-JMS099.30 | 3/23/1995 | M | 3 | 14.58 | | 10.27 | | | 0 | |
| 2-JMS099.30 | 3/23/1995 | M | 5 | 14.56 | | 10.25 | | | 0 | |
| 2-JMS099.30 | 3/23/1995 | M | 7 | 14.54 | | 10.25 | | | 0 | |
| 2-JMS099.30 | 3/23/1995 | B | 9 | 14.54 | | 10.24 | | | 0 | |
| 2-JMS099.30 | 3/23/1995 | S | 10 | 14.56 | 7.65 | 10.21 | | | 0 | |
| 2-JMS099.30 | 4/18/1995 | S | 1 | 16.9 | 7.73 | 9.4 | | | 0 | 1.6 |
| 2-JMS099.30 | 4/18/1995 | M | 3 | 16.78 | | 9.39 | | | 0 | |
| 2-JMS099.30 | 4/18/1995 | M | 5 | 16.73 | | 9.34 | | | 0 | |
| 2-JMS099.30 | 4/18/1995 | M | 7 | 16.73 | | 9.33 | | | 0 | |
| 2-JMS099.30 | 4/18/1995 | B | 9 | 16.53 | | 9.29 | | | 0 | |
| 2-JMS099.30 | 4/18/1995 | S | 11 | 16.53 | 7.62 | 9.27 | | | 0 | |
| 2-JMS099.30 | 5/3/1995 | S | 0.3 | 15.81 | 7.25 | 8.81 | | | | |
| 2-JMS099.30 | 5/18/1995 | S | 0.3 | 21.22 | 7.19 | 7.92 | | | | |
| 2-JMS099.30 | 5/23/1995 | S | 1 | 24.3 | 7.6 | 8.4 | | | 0 | 1.5 |
| 2-JMS099.30 | 5/23/1995 | S | 11 | 23.22 | 7.35 | 8.21 | | | 0 | |
| 2-JMS099.30 | 6/1/1995 | S | 0.3 | 24.51 | 7.36 | 8.42 | | | | |
| 2-JMS099.30 | 6/20/1995 | S | 1 | 24.88 | 7.33 | 7.88 | | | 0 | 1 |
| 2-JMS099.30 | 6/20/1995 | M | 3 | 24.49 | | 7.74 | | | 0 | |
| 2-JMS099.30 | 6/20/1995 | M | 5 | 24.51 | | 7.77 | | | 0 | |
| 2-JMS099.30 | 6/20/1995 | M | 7 | 24.5 | | 7.68 | | | 0 | |
| 2-JMS099.30 | 6/20/1995 | M | 9 | 24.4 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 6/20/1995 | B | 11 | 24.4 | | 7.53 | | | 0 | |
| 2-JMS099.30 | 6/20/1995 | S | 12 | 24.36 | 7.25 | 7.38 | | | 0 | |
| 2-JMS099.30 | 7/18/1995 | S | 1 | 29.95 | 7.3 | 7.31 | | | 0 | 0.7 |
| 2-JMS099.30 | 7/18/1995 | M | 3 | 29.87 | | 7.19 | | | 0 | |
| 2-JMS099.30 | 7/18/1995 | M | 5 | 29.52 | | 6.92 | | | 0 | |
| 2-JMS099.30 | 7/18/1995 | M | 7 | 29.45 | | 6.84 | | | 0 | |
| 2-JMS099.30 | 7/18/1995 | B | 9 | 29.45 | | 6.76 | | | 0 | |
| 2-JMS099.30 | 7/18/1995 | S | 11 | 29.45 | 7.28 | 6.78 | | | 0 | |
| 2-JMS099.30 | 7/31/1995 | S | 0.3 | 31.35 | 7.89 | 5.84 | | | 0 | |
| 2-JMS099.30 | 8/23/1995 | S | 1 | 32.11 | 8.23 | 8.68 | | | 0 | 0.8 |
| 2-JMS099.30 | 8/23/1995 | M | 3 | 30.78 | | 7.25 | | | 0 | |
| 2-JMS099.30 | 8/23/1995 | M | 5 | 29.6 | | 7.08 | | | 0 | |
| 2-JMS099.30 | 8/23/1995 | M | 7 | 29.5 | | 6.89 | | | 0 | |
| 2-JMS099.30 | 8/23/1995 | M | 9 | 29.41 | | 6.77 | | | 0 | |
| 2-JMS099.30 | 8/23/1995 | B | 11 | 29.4 | | 6.73 | | | 0 | |
| 2-JMS099.30 | 8/23/1995 | S | 12 | 29.37 | 7.65 | 6.75 | | | 0 | |
| 2-JMS099.30 | 8/28/1995 | S | 0.3 | 28.6 | 7.48 | 7.17 | | | | |
| 2-JMS099.30 | 9/11/1995 | S | 0.3 | 26.77 | 7.66 | 8.87 | | | | |
| 2-JMS099.30 | 9/20/1995 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 9/21/1995 | S | 1 | 25.14 | 7.82 | 7.74 | | | 0 | 1.1 |
| 2-JMS099.30 | 9/21/1995 | M | 3 | 23.92 | | 7.27 | | | 0 | |
| 2-JMS099.30 | 9/21/1995 | M | 5 | 23.77 | | 7.22 | | | 0 | |
| 2-JMS099.30 | 9/21/1995 | M | 7 | 23.55 | | 7.12 | | | 0 | |
| 2-JMS099.30 | 9/21/1995 | M | 9 | 23.47 | | 7.08 | | | 0 | |
| 2-JMS099.30 | 9/21/1995 | B | 11 | 23.48 | | 7.05 | | | 0 | |
| 2-JMS099.30 | 9/21/1995 | S | 12 | 23.48 | 7.54 | 7.05 | | | 0 | |
| 2-JMS099.30 | 10/5/1995 | S | 0.3 | 21.67 | 7.69 | 7.95 | | | | |
| 2-JMS099.30 | 10/19/1995 | S | 1 | 18.3 | 7.42 | 8.72 | | | 0 | 1.1 |
| 2-JMS099.30 | 10/19/1995 | M | 3 | 18.05 | | 8.7 | | | 0 | |
| 2-JMS099.30 | 10/19/1995 | M | 5 | 17.9 | | 8.7 | | | 0 | |
| 2-JMS099.30 | 10/19/1995 | M | 7 | 17.84 | | 8.69 | | | 0 | |
| 2-JMS099.30 | 10/19/1995 | B | 9 | 17.69 | 7.42 | 8.66 | | | 0 | |
| 2-JMS099.30 | 10/19/1995 | S | 12 | | | | | | | |
| 2-JMS099.30 | 10/24/1995 | S | 0.3 | 15.22 | 7.14 | 9.86 | | | | |
| 2-JMS099.30 | 11/20/1995 | S | 1 | 6.64 | 7.37 | 12.22 | | | 0 | 0.7 |
| 2-JMS099.30 | 11/20/1995 | M | 3 | 6.65 | | 12.21 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 11/20/1995 | M | 5 | 6.65 | | 12.24 | | | 0 | |
| 2-JMS099.30 | 11/20/1995 | M | 7 | 6.63 | | 12.25 | | | 0 | |
| 2-JMS099.30 | 11/20/1995 | B | 9 | 6.63 | | 12.25 | | | 0 | |
| 2-JMS099.30 | 11/20/1995 | S | 11 | 6.61 | 7.36 | 11.75 | | | 0 | |
| 2-JMS099.30 | 12/14/1995 | S | 1 | 2.82 | 7.33 | 13.61 | | | 0 | 1.3 |
| 2-JMS099.30 | 12/14/1995 | M | 3 | 2.82 | | 13.58 | | | 0 | |
| 2-JMS099.30 | 12/14/1995 | M | 5 | 2.82 | | 13.57 | | | 0 | |
| 2-JMS099.30 | 12/14/1995 | M | 7 | 2.8 | | 13.52 | | | 0 | |
| 2-JMS099.30 | 12/14/1995 | B | 9 | 2.8 | | 13.52 | | | 0 | |
| 2-JMS099.30 | 12/14/1995 | S | 10 | 2.81 | 7.33 | 13.52 | | | 0 | |
| 2-JMS099.30 | 1/29/1996 | S | 11 | 4.32 | 7.27 | 13.28 | | | 0 | |
| 2-JMS099.30 | 1/29/1996 | S | 1 | 4.33 | 7.29 | 13.11 | | | 0 | 0.1 |
| 2-JMS099.30 | 1/29/1996 | M | 3 | 4.33 | | 13.2 | | | 0 | |
| 2-JMS099.30 | 1/29/1996 | M | 5 | 4.33 | | 13.25 | | | 0 | |
| 2-JMS099.30 | 1/29/1996 | M | 7 | 4.33 | | 13.27 | | | 0 | |
| 2-JMS099.30 | 1/29/1996 | B | 9 | 4.35 | | 13.3 | | | 0 | |
| 2-JMS099.30 | 2/20/1996 | S | 1 | 3.86 | 7.43 | 13.36 | | | 0 | 0.9 |
| 2-JMS099.30 | 2/20/1996 | M | 3 | 3.81 | | 13.4 | | | 0 | |
| 2-JMS099.30 | 2/20/1996 | M | 5 | 3.81 | | 13.4 | | | 0 | |
| 2-JMS099.30 | 2/20/1996 | M | 7 | 3.81 | | 13.4 | | | 0 | |
| 2-JMS099.30 | 2/20/1996 | B | 9 | 3.81 | | 13.43 | | | 0 | |
| 2-JMS099.30 | 2/20/1996 | S | 11 | 3.78 | 7.39 | 13.5 | | | 0 | |
| 2-JMS099.30 | 3/25/1996 | S | 10 | 8.75 | 7.22 | 11.45 | | | 0 | |
| 2-JMS099.30 | 3/25/1996 | S | 1 | 8.81 | 7.24 | 11.63 | | | 0 | 0.5 |
| 2-JMS099.30 | 3/25/1996 | M | 3 | 8.76 | | 11.62 | | | 0 | |
| 2-JMS099.30 | 3/25/1996 | M | 5 | 8.75 | | 11.57 | | | 0 | |
| 2-JMS099.30 | 3/25/1996 | M | 7 | 8.75 | | 11.48 | | | 0 | |
| 2-JMS099.30 | 3/25/1996 | B | 9 | 8.75 | | 11.43 | | | 0 | |
| 2-JMS099.30 | 4/29/1996 | S | 10 | 17.8 | 7.59 | 8.98 | | | 0 | |
| 2-JMS099.30 | 4/29/1996 | S | 1 | 18.45 | 8.08 | 9.45 | | | 0 | 1.2 |
| 2-JMS099.30 | 4/29/1996 | M | 3 | 18.01 | | 9.03 | | | 0 | |
| 2-JMS099.30 | 4/29/1996 | M | 5 | 17.95 | | 9.03 | | | 0 | |
| 2-JMS099.30 | 4/29/1996 | M | 7 | 17.94 | | 9 | | | 0 | |
| 2-JMS099.30 | 4/29/1996 | B | 9 | 17.82 | | 8.96 | | | 0 | |
| 2-JMS099.30 | 5/6/1996 | S | 0.3 | 22 | 8.82 | 8.62 | | | | |
| 2-JMS099.30 | 5/15/1996 | S | 10 | 19.83 | 7.88 | 9.74 | | | 0 | |
| 2-JMS099.30 | 5/15/1996 | S | 1 | 20.16 | 8.32 | 10.3 | | | 0 | 1.1 |
| 2-JMS099.30 | 5/15/1996 | M | 3 | 20 | | 10.17 | | | 0 | |
| 2-JMS099.30 | 5/15/1996 | M | 5 | 19.88 | | 10.01 | | | 0 | |
| 2-JMS099.30 | 5/15/1996 | M | 7 | 19.86 | | 9.94 | | | 0 | |
| 2-JMS099.30 | 5/15/1996 | B | 9 | 19.83 | | 9.85 | | | 0 | |
| 2-JMS099.30 | 5/28/1996 | S | 0.3 | 19.89 | 7.43 | 8.86 | | | | |
| 2-JMS099.30 | 6/3/1996 | S | 0.3 | 21.47 | 7.97 | 9.31 | | | | |
| 2-JMS099.30 | 6/12/1996 | S | 0.3 | 24.68 | 7.19 | 7.9 | | | | |
| 2-JMS099.30 | 6/18/1996 | S | 1 | 27.97 | 7.51 | 7.6 | | | 0 | 1 |
| 2-JMS099.30 | 6/18/1996 | M | 3 | 27.97 | | 7.6 | | | 0 | |
| 2-JMS099.30 | 6/18/1996 | M | 5 | 27.65 | | 7.45 | | | 0 | |
| 2-JMS099.30 | 6/18/1996 | M | 7 | 27.63 | | 7.46 | | | 0 | |
| 2-JMS099.30 | 6/18/1996 | B | 9 | 27.61 | | 7.43 | | | 0 | |
| 2-JMS099.30 | 6/18/1996 | S | 11 | 27.53 | 7.38 | 7.39 | | | | |
| 2-JMS099.30 | 6/18/1996 | B | 12 | 27.53 | 7.38 | 7.39 | | | 0 | |
| 2-JMS099.30 | 7/1/1996 | S | 0.3 | 27.97 | 7.9 | 7.09 | | | | |
| 2-JMS099.30 | 7/15/1996 | S | 0.3 | 27.01 | 7.3 | 7.06 | | | | |
| 2-JMS099.30 | 7/23/1996 | S | 11 | 28.16 | 7.21 | 6.38 | | | 0 | |
| 2-JMS099.30 | 7/23/1996 | S | 1 | 28.45 | 7.42 | 6.79 | | | 0 | 1.1 |
| 2-JMS099.30 | 7/23/1996 | M | 3 | 28.4 | | 6.67 | | | 0 | |
| 2-JMS099.30 | 7/23/1996 | M | 5 | 28.3 | | 6.5 | | | 0 | |
| 2-JMS099.30 | 7/23/1996 | M | 7 | 28.2 | | 6.4 | | | 0 | |
| 2-JMS099.30 | 7/23/1996 | B | 9 | 28.18 | | 6.41 | | | 0 | |
| 2-JMS099.30 | 8/1/1996 | S | 0.3 | 28.05 | 7.49 | 6.94 | | | | |
| 2-JMS099.30 | 8/15/1996 | S | 0.3 | 24.91 | 7.41 | 7.91 | | | | |
| 2-JMS099.30 | 8/20/1996 | S | 1 | 27.32 | 7.55 | 7.47 | | | 0 | 1.3 |
| 2-JMS099.30 | 8/20/1996 | M | 3 | 26.98 | | 7.27 | | | 0 | |
| 2-JMS099.30 | 8/20/1996 | M | 5 | 26.97 | | 7.27 | | | 0 | |
| 2-JMS099.30 | 8/20/1996 | M | 7 | 26.96 | | 7.25 | | | 0 | |
| 2-JMS099.30 | 8/20/1996 | M | 9 | 26.96 | | 7.25 | | | 0 | |
| 2-JMS099.30 | 8/20/1996 | B | 11 | 26.96 | | 7.24 | | | 0 | |
| 2-JMS099.30 | 8/20/1996 | S | 12 | 26.95 | 7.47 | 7.24 | | | 0 | |
| 2-JMS099.30 | 9/16/1996 | S | 0.3 | 22.25 | 7.62 | 8 | | | | |
| 2-JMS099.30 | 9/24/1996 | S | 12 | 20.41 | 7.69 | 8.54 | | | 0 | |
| 2-JMS099.30 | 9/24/1996 | S | 1 | 20.87 | 7.78 | 8.62 | | | 0 | 0.9 |
| 2-JMS099.30 | 9/24/1996 | M | 3 | 20.64 | | 8.61 | | | 0 | |
| 2-JMS099.30 | 9/24/1996 | M | 5 | 20.52 | | 8.58 | | | 0 | |
| 2-JMS099.30 | 9/24/1996 | M | 7 | 20.43 | | 8.56 | | | 0 | |
| 2-JMS099.30 | 9/24/1996 | M | 9 | 20.4 | | 8.54 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 9/24/1996 | B | 11 | 20.4 | | 8.54 | | | 0 | |
| 2-JMS099.30 | 9/30/1996 | S | 0.3 | 21.74 | 7.92 | 8.1 | | | | |
| 2-JMS099.30 | 10/9/1996 | S | 0.3 | 15.82 | 7.34 | 9.23 | | | | |
| 2-JMS099.30 | 10/22/1996 | S | 1 | 15.06 | 7.14 | 9.42 | | | 0 | 0.5 |
| 2-JMS099.30 | 10/22/1996 | M | 3 | 14.54 | | 9.44 | | | 0 | |
| 2-JMS099.30 | 10/22/1996 | M | 5 | 14.45 | | 9.43 | | | 0 | |
| 2-JMS099.30 | 10/22/1996 | M | 7 | 14.45 | | 9.4 | | | 0 | |
| 2-JMS099.30 | 10/22/1996 | M | 9 | 14.45 | | 9.41 | | | 0 | |
| 2-JMS099.30 | 10/22/1996 | B | 11 | 14.45 | | 9.41 | | | 0 | |
| 2-JMS099.30 | 10/22/1996 | S | 12 | 14.45 | 7.13 | 9.41 | | | 0 | |
| 2-JMS099.30 | 10/30/1996 | S | 0.3 | 17.11 | 7.88 | 10.05 | | | | |
| 2-JMS099.30 | 11/19/1996 | S | 11 | 6.04 | 7.38 | 12.33 | | | 0 | |
| 2-JMS099.30 | 11/19/1996 | S | 1 | 6.04 | 7.44 | 12.33 | | | 0 | 2 |
| 2-JMS099.30 | 11/19/1996 | M | 3 | 6.02 | | 12.35 | | | 0 | |
| 2-JMS099.30 | 11/19/1996 | M | 5 | 6.02 | | 12.33 | | | 0 | |
| 2-JMS099.30 | 11/19/1996 | M | 7 | 6.02 | | 12.34 | | | 0 | |
| 2-JMS099.30 | 11/19/1996 | B | 9 | 6.04 | | 12.33 | | | 0 | |
| 2-JMS099.30 | 12/10/1996 | S | 12 | 5.14 | 6.98 | 12.4 | | | 0 | |
| 2-JMS099.30 | 12/10/1996 | S | 1 | 5.14 | 7.12 | 12.56 | | | 0 | 0.5 |
| 2-JMS099.30 | 12/10/1996 | M | 3 | 5.14 | | 12.57 | | | 0 | |
| 2-JMS099.30 | 12/10/1996 | M | 5 | 5.14 | | 12.63 | | | 0 | |
| 2-JMS099.30 | 12/10/1996 | M | 7 | 5.14 | | 12.61 | | | 0 | |
| 2-JMS099.30 | 12/10/1996 | M | 9 | 5.14 | | 12.61 | | | 0 | |
| 2-JMS099.30 | 12/10/1996 | B | 11 | 5.14 | | 12.47 | | | 0 | |
| 2-JMS099.30 | 2/18/1997 | S | 3 | 5.71 | | 13.58 | | | 0 | |
| 2-JMS099.30 | 2/18/1997 | M | 5 | 5.69 | | 13.66 | | | 0 | |
| 2-JMS099.30 | 2/18/1997 | M | 7 | 5.69 | | 13.67 | | | 0 | |
| 2-JMS099.30 | 2/18/1997 | M | 9 | 5.69 | | 13.73 | | | 0 | |
| 2-JMS099.30 | 2/18/1997 | B | 11 | 5.71 | 7.24 | 14.08 | | | 0 | |
| 2-JMS099.30 | 2/18/1997 | S | 1 | 5.74 | 7.24 | 13.57 | | | 0 | 0.6 |
| 2-JMS099.30 | 3/18/1997 | S | 10 | 10.07 | 7.65 | 11.28 | | | 0 | |
| 2-JMS099.30 | 3/18/1997 | S | 1 | 10.15 | 7.71 | 11.09 | | | 0 | 1.1 |
| 2-JMS099.30 | 3/18/1997 | M | 3 | 10.14 | | 11.1 | | | 0 | |
| 2-JMS099.30 | 3/18/1997 | M | 5 | 10.09 | | 11.13 | | | 0 | |
| 2-JMS099.30 | 3/18/1997 | M | 7 | 10.07 | | 11.15 | | | 0 | |
| 2-JMS099.30 | 3/18/1997 | B | 9 | 10.07 | | 11.24 | | | 0 | |
| 2-JMS099.30 | 4/22/1997 | S | 1 | 14.04 | 7.61 | 9.75 | | | 0 | 1.2 |
| 2-JMS099.30 | 4/22/1997 | M | 3 | 14.01 | | 9.73 | | | 0 | |
| 2-JMS099.30 | 4/22/1997 | M | 5 | 13.99 | | 9.73 | | | 0 | |
| 2-JMS099.30 | 4/22/1997 | M | 7 | 13.98 | | 9.74 | | | 0 | |
| 2-JMS099.30 | 4/22/1997 | B | 9 | 13.98 | | 9.76 | | | 0 | |
| 2-JMS099.30 | 4/22/1997 | S | 10 | 13.98 | 7.5 | 9.78 | | | 0 | |
| 2-JMS099.30 | 5/21/1997 | S | 0.3 | 22.1 | 7.34 | 7.18 | | | | |
| 2-JMS099.30 | 5/27/1997 | S | 0.3 | 21.94 | 7.32 | 7.02 | | | | |
| 2-JMS099.30 | 5/28/1997 | S | 1 | 21.72 | 7.27 | 7.13 | | | 0 | 1.5 |
| 2-JMS099.30 | 5/28/1997 | M | 3 | 21.62 | | 7.14 | | | 0 | |
| 2-JMS099.30 | 5/28/1997 | M | 5 | 21.57 | | 7.15 | | | 0 | |
| 2-JMS099.30 | 5/28/1997 | M | 7 | 21.44 | | 7.17 | | | 0 | |
| 2-JMS099.30 | 5/28/1997 | M | 9 | 21.28 | | 7.15 | | | 0 | |
| 2-JMS099.30 | 5/28/1997 | B | 11 | 21.27 | | 7.16 | | | 0 | |
| 2-JMS099.30 | 5/28/1997 | S | 12 | 21.27 | 7.23 | 7.19 | | | 0 | |
| 2-JMS099.30 | 6/3/1997 | S | 0.3 | 22.37 | 7.07 | 6.92 | | | | |
| 2-JMS099.30 | 6/23/1997 | S | 0.3 | 28.76 | 7.76 | 6.8 | | | | |
| 2-JMS099.30 | 6/24/1997 | S | 1 | 30.26 | 7.93 | 6.76 | | | 0 | 1 |
| 2-JMS099.30 | 6/24/1997 | M | 3 | 29.37 | | 6.31 | | | 0 | |
| 2-JMS099.30 | 6/24/1997 | M | 5 | 29.35 | | 6.31 | | | 0 | |
| 2-JMS099.30 | 6/24/1997 | M | 7 | 29.31 | | 6.31 | | | 0 | |
| 2-JMS099.30 | 6/24/1997 | B | 9 | 29.31 | | 6.32 | | | 0 | |
| 2-JMS099.30 | 6/24/1997 | S | 10 | 29.31 | 7.7 | 6.33 | | | 0 | |
| 2-JMS099.30 | 7/9/1997 | S | 0.3 | 29.33 | 7.67 | 6.87 | | | | |
| 2-JMS099.30 | 7/15/1997 | S | 1 | 30.53 | 8.45 | | | | | |
| 2-JMS099.30 | 7/15/1997 | S | 11 | 28.91 | 7.6 | | | | | |
| 2-JMS099.30 | 7/23/1997 | S | 0.3 | 29.3 | 7.42 | | | | | |
| 2-JMS099.30 | 8/7/1997 | S | 0.3 | 28.42 | 7.47 | 6.27 | | | | |
| 2-JMS099.30 | 8/19/1997 | S | 1 | 30.83 | 7.49 | 6.58 | | | 0 | 1 |
| 2-JMS099.30 | 8/19/1997 | S | 11 | 30.3 | 7.38 | 6.25 | | | 0 | |
| 2-JMS099.30 | 8/21/1997 | S | 0.3 | 29.6 | 7.38 | 6.7 | | | | |
| 2-JMS099.30 | 9/4/1997 | S | 0.3 | 26.36 | 7.75 | 7 | | | | |
| 2-JMS099.30 | 9/23/1997 | S | 1 | 24.74 | 7.76 | 7.67 | | | 0 | 1.1 |
| 2-JMS099.30 | 9/23/1997 | S | 11 | 24.46 | 7.59 | 7.37 | | | 0 | |
| 2-JMS099.30 | 10/2/1997 | S | 0.3 | 21.31 | 7.66 | 8 | | | | |
| 2-JMS099.30 | 10/20/1997 | S | 0.3 | 16.89 | 7.61 | 8.51 | | | | |
| 2-JMS099.30 | 10/21/1997 | S | 1 | 16.12 | 7.68 | 9.02 | | | 0 | 1.2 |
| 2-JMS099.30 | 10/21/1997 | B | 3 | 16.07 | | 9 | | | | |
| 2-JMS099.30 | 10/21/1997 | S | 9 | 16.07 | 7.67 | 9.04 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 11/18/1997 | S | 1 | 7.97 | 7.56 | 11.44 | | | | 1.3 |
| 2-JMS099.30 | 11/18/1997 | S | 11 | 7.89 | 7.53 | 11.39 | | | | |
| 2-JMS099.30 | 12/10/1997 | S | 1 | 5.86 | 7.62 | 10.92 | | | | 1.7 |
| 2-JMS099.30 | 12/10/1997 | M | 3 | 5.86 | | 10.9 | | | 0 | |
| 2-JMS099.30 | 12/10/1997 | B | 5 | 5.86 | | 10.9 | | | 0 | |
| 2-JMS099.30 | 12/10/1997 | S | 7 | 5.95 | 7.61 | 10.88 | | | | |
| 2-JMS099.30 | 1/21/1998 | S | 1 | 5.56 | 7.81 | 11.16 | | | | 0.5 |
| 2-JMS099.30 | 1/21/1998 | M | 3 | 5.56 | | 11.18 | | | | |
| 2-JMS099.30 | 1/21/1998 | M | 5 | 5.55 | | 11.19 | | | | |
| 2-JMS099.30 | 1/21/1998 | M | 7 | 5.56 | | 11.16 | | | | |
| 2-JMS099.30 | 1/21/1998 | M | 9 | 5.57 | | 11.17 | | | | |
| 2-JMS099.30 | 1/21/1998 | B | 11 | 5.57 | | 11.2 | | | | |
| 2-JMS099.30 | 1/21/1998 | S | 12 | 5.56 | 7.8 | 11.25 | | | | |
| 2-JMS099.30 | 2/18/1998 | S | 1 | 7.24 | 7.2 | 11.96 | | | | 0.2 |
| 2-JMS099.30 | 2/18/1998 | M | 3 | 7.24 | | 11.96 | | | | |
| 2-JMS099.30 | 2/18/1998 | M | 5 | 7.24 | | 11.96 | | | | |
| 2-JMS099.30 | 2/18/1998 | M | 7 | 7.24 | | 11.95 | | | | |
| 2-JMS099.30 | 2/18/1998 | M | 9 | 7.24 | | 11.97 | | | | |
| 2-JMS099.30 | 2/18/1998 | B | 11 | 7.24 | | 11.96 | | | | |
| 2-JMS099.30 | 2/18/1998 | S | 12 | 7.24 | 7.2 | 12.03 | | | 0 | |
| 2-JMS099.30 | 3/17/1998 | S | 1 | 6.93 | 7.57 | 12.85 | | | | 1.1 |
| 2-JMS099.30 | 3/17/1998 | M | 3 | 6.93 | | 12.83 | | | | |
| 2-JMS099.30 | 3/17/1998 | B | 5 | 6.91 | | 12.84 | | | | |
| 2-JMS099.30 | 3/17/1998 | S | 7 | 6.91 | 7.57 | 12.81 | | | | |
| 2-JMS099.30 | 4/21/1998 | S | 1 | 14.58 | 7.43 | 10.9 | | | | 0.3 |
| 2-JMS099.30 | 4/21/1998 | M | 3 | 14.57 | | 10.9 | | | | |
| 2-JMS099.30 | 4/21/1998 | M | 5 | 14.57 | | 10.9 | | | | |
| 2-JMS099.30 | 4/21/1998 | B | 7 | 14.57 | | 10.9 | | | | |
| 2-JMS099.30 | 4/21/1998 | S | 9 | 14.57 | | 10.9 | | | | |
| 2-JMS099.30 | 4/21/1998 | B | 10 | 14.57 | 7.4 | 10.9 | | | | |
| 2-JMS099.30 | 5/18/1998 | S | 0.3 | 22.17 | 7.87 | 8.46 | | | | |
| 2-JMS099.30 | 5/19/1998 | S | 1 | 23.27 | 7.74 | 8.56 | | | | 0.8 |
| 2-JMS099.30 | 5/19/1998 | M | 3 | 22.96 | | 8.46 | | | | |
| 2-JMS099.30 | 5/19/1998 | M | 5 | 22.71 | | 8.46 | | | | |
| 2-JMS099.30 | 5/19/1998 | B | 7 | 22.68 | | 8.47 | | | | |
| 2-JMS099.30 | 5/19/1998 | S | 9 | 22.66 | 7.66 | 8.52 | | | | |
| 2-JMS099.30 | 5/27/1998 | S | 0.3 | 24.21 | 8.35 | 8.61 | | | | |
| 2-JMS099.30 | 6/17/1998 | S | 0.3 | 25.75 | 7.66 | 7.53 | | | | |
| 2-JMS099.30 | 6/23/1998 | S | 14 | 27.28 | 7.78 | 7.69 | | | | |
| 2-JMS099.30 | 6/23/1998 | S | 1 | 28 | 8.14 | 8.75 | | | | 0.7 |
| 2-JMS099.30 | 6/23/1998 | M | 3 | 27.73 | | 8.68 | | | | |
| 2-JMS099.30 | 6/23/1998 | M | 5 | 27.56 | | 8.03 | | | | |
| 2-JMS099.30 | 6/23/1998 | M | 7 | 27.43 | | 7.98 | | | | |
| 2-JMS099.30 | 6/23/1998 | M | 9 | 27.34 | | 7.8 | | | | |
| 2-JMS099.30 | 6/23/1998 | M | 11 | 27.31 | | 7.73 | | | | |
| 2-JMS099.30 | 6/23/1998 | B | 13 | 27.79 | | 7.69 | | | | |
| 2-JMS099.30 | 6/30/1998 | S | 0.3 | 29.45 | 7.5 | 6.94 | | | | |
| 2-JMS099.30 | 7/14/1998 | S | 0.3 | 28.4 | 7.75 | 8.5 | | | | |
| 2-JMS099.30 | 7/21/1998 | S | 1 | 33.07 | 8.6 | 8.9 | | | | |
| 2-JMS099.30 | 7/21/1998 | M | 3 | 31.02 | | 7.45 | | | | |
| 2-JMS099.30 | 7/21/1998 | M | 5 | 30.65 | | 7.25 | | | | |
| 2-JMS099.30 | 7/21/1998 | M | 7 | 30.39 | | 7 | | | | |
| 2-JMS099.30 | 7/21/1998 | M | 9 | 30.04 | | 6.75 | | | | |
| 2-JMS099.30 | 7/21/1998 | B | 11 | 30.02 | | 6.68 | | | | |
| 2-JMS099.30 | 7/21/1998 | S | 12 | 30 | 8.01 | 6.65 | | | | |
| 2-JMS099.30 | 7/28/1998 | S | 0.3 | 29.73 | 7.8 | 7.62 | | | | |
| 2-JMS099.30 | 8/11/1998 | S | 0.3 | 28.61 | 7.66 | 7.21 | | | | |
| 2-JMS099.30 | 8/18/1998 | S | 10 | 28.3 | 7.62 | 6.43 | | | 0 | |
| 2-JMS099.30 | 8/18/1998 | S | 1 | 28.73 | 7.73 | 6.8 | | | | 1 |
| 2-JMS099.30 | 8/18/1998 | M | 3 | 28.66 | | 6.82 | | | | |
| 2-JMS099.30 | 8/18/1998 | M | 5 | 28.44 | | 6.71 | | | | |
| 2-JMS099.30 | 8/18/1998 | M | 7 | 28.31 | | 6.57 | | | | |
| 2-JMS099.30 | 8/18/1998 | B | 9 | 28.3 | | 6.49 | | | | |
| 2-JMS099.30 | 8/25/1998 | S | 0.3 | 28.26 | 8.13 | 7.4 | | | | |
| 2-JMS099.30 | 9/14/1998 | S | 0.3 | 28.45 | 8.3 | 9.37 | | | | |
| 2-JMS099.30 | 9/22/1998 | S | 1 | 28.75 | 7.87 | 7.1 | | | 0 | 0.8 |
| 2-JMS099.30 | 9/22/1998 | M | 3 | 28.4 | | 6.85 | | | | |
| 2-JMS099.30 | 9/22/1998 | M | 5 | 28 | | 6.64 | | | | |
| 2-JMS099.30 | 9/22/1998 | M | 7 | 27.95 | | 6.55 | | | | |
| 2-JMS099.30 | 9/22/1998 | B | 9 | 27.88 | | 6.59 | | | | |
| 2-JMS099.30 | 9/22/1998 | S | 11 | 27.79 | 7.69 | 6.48 | | | 0 | |
| 2-JMS099.30 | 9/29/1998 | S | 0.3 | 28.91 | 8.24 | 8.31 | | | | |
| 2-JMS099.30 | 10/13/1998 | S | 0.3 | 20.28 | 7.86 | 8.4 | | | | |
| 2-JMS099.30 | 10/20/1998 | S | 9 | 19.92 | 7.7 | 8.2 | | | | |
| 2-JMS099.30 | 10/20/1998 | S | 1 | 20.75 | 7.76 | 8.47 | | | | 0.8 |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 10/20/1998 | M | 3 | 20.85 | | 8.41 | | | | |
| 2-JMS099.30 | 10/20/1998 | M | 5 | 20.75 | | 8.41 | | | | |
| 2-JMS099.30 | 10/20/1998 | B | 7 | 20.61 | | 8.38 | | | | |
| 2-JMS099.30 | 10/26/1998 | S | 0.3 | 17.8 | 7.76 | 8.9 | | | | |
| 2-JMS099.30 | 11/18/1998 | S | 1 | 13.81 | 7.54 | 10.49 | | | 0.2 | 1.2 |
| 2-JMS099.30 | 11/18/1998 | M | 3 | 12.57 | | 10.51 | | | 0.2 | |
| 2-JMS099.30 | 11/18/1998 | M | 5 | 12.41 | | 10.51 | | | 0.2 | |
| 2-JMS099.30 | 11/18/1998 | M | 7 | 12.28 | | 10.53 | | | 0.2 | |
| 2-JMS099.30 | 11/18/1998 | M | 9 | 12.29 | | 10.52 | | | 0.2 | |
| 2-JMS099.30 | 11/18/1998 | B | 11 | 12.23 | | 10.55 | | | 0.2 | |
| 2-JMS099.30 | 11/18/1998 | S | 12 | 12.21 | 7.53 | 10.56 | | | 0.2 | |
| 2-JMS099.30 | 12/15/1998 | S | 9 | 9.82 | | 11.32 | | | | |
| 2-JMS099.30 | 12/15/1998 | B | 11 | 9.82 | | 11.46 | | | | |
| 2-JMS099.30 | 12/15/1998 | S | 12 | 9.82 | 7.17 | 11.46 | | | | |
| 2-JMS099.30 | 12/15/1998 | S | 1 | 10.18 | 7.21 | 11.2 | | | | 0.7 |
| 2-JMS099.30 | 12/15/1998 | M | 3 | 10 | | 11.27 | | | | |
| 2-JMS099.30 | 12/15/1998 | M | 5 | 9.83 | | 11 | | | | |
| 2-JMS099.30 | 12/15/1998 | B | 7 | 9.82 | | 11.22 | | | | |
| 2-JMS099.30 | 1/19/1999 | S | 1 | 6.09 | 7.33 | 12.26 | | | | 0.5 |
| 2-JMS099.30 | 1/19/1999 | M | 3 | 6.05 | | 12.27 | | | | |
| 2-JMS099.30 | 1/19/1999 | M | 5 | 6.02 | | 12.29 | | | | |
| 2-JMS099.30 | 1/19/1999 | M | 7 | 6 | | 12.31 | | | | |
| 2-JMS099.30 | 1/19/1999 | M | 9 | 6 | | 12.31 | | | | |
| 2-JMS099.30 | 1/19/1999 | B | 10 | 6.05 | 7.34 | 12.35 | | | | |
| 2-JMS099.30 | 2/23/1999 | B | 10 | 6.2 | 7.61 | 12.7 | | | | |
| 2-JMS099.30 | 2/23/1999 | S | 1 | 6.32 | 7.73 | 12.65 | | | 0 | 1.3 |
| 2-JMS099.30 | 2/23/1999 | M | 3 | 6.28 | | 12.65 | | | | |
| 2-JMS099.30 | 2/23/1999 | M | 5 | 6.26 | | 12.78 | | | | |
| 2-JMS099.30 | 2/23/1999 | M | 7 | 6.21 | | 12.79 | | | | |
| 2-JMS099.30 | 2/23/1999 | M | 9 | 6.24 | | 12.7 | | | | |
| 2-JMS099.30 | 3/23/1999 | S | 1 | 9.52 | 7.1 | 11.12 | | | | 0.7 |
| 2-JMS099.30 | 3/23/1999 | M | 3 | 9.55 | | 11.06 | | | | |
| 2-JMS099.30 | 3/23/1999 | M | 5 | 9.54 | | 11.11 | | | | |
| 2-JMS099.30 | 3/23/1999 | M | 7 | 9.51 | | 11.14 | | | | |
| 2-JMS099.30 | 3/23/1999 | M | 9 | 9.51 | | 11.08 | | | | |
| 2-JMS099.30 | 3/23/1999 | B | 10 | | | | | | | |
| 2-JMS099.30 | 4/20/1999 | B | 9 | 16.11 | 7.58 | 8.59 | | | 0.1 | |
| 2-JMS099.30 | 4/20/1999 | S | 1 | 16.41 | 7.75 | 8.79 | | | 0.1 | 0.5 |
| 2-JMS099.30 | 4/20/1999 | M | 3 | 16.31 | | 8.64 | | | 0.1 | |
| 2-JMS099.30 | 4/20/1999 | M | 5 | 16.32 | | 8.64 | | | 0.1 | |
| 2-JMS099.30 | 4/20/1999 | M | 7 | 16.29 | | 8.7 | | | 0.1 | |
| 2-JMS099.30 | 5/11/1999 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 5/20/1999 | B | 8 | 21.88 | 7.43 | 8 | | | | |
| 2-JMS099.30 | 5/20/1999 | S | 1 | 22.08 | 7.45 | 8 | | | | |
| 2-JMS099.30 | 5/20/1999 | M | 3 | 21.96 | | 8 | | | | |
| 2-JMS099.30 | 5/20/1999 | M | 5 | 21.92 | | 8.01 | | | | |
| 2-JMS099.30 | 5/20/1999 | M | 7 | 21.86 | | 8 | | | | |
| 2-JMS099.30 | 5/25/1999 | S | 0.3 | 23.97 | 7.24 | 6.64 | | | | |
| 2-JMS099.30 | 6/7/1999 | S | 0.3 | 28.88 | 8.81 | 10.2 | | | | |
| 2-JMS099.30 | 6/21/1999 | S | 0.3 | 24.58 | 6.98 | 5.45 | | | | |
| 2-JMS099.30 | 6/22/1999 | B | 9 | 23.63 | 7.05 | 6.34 | | | 0 | |
| 2-JMS099.30 | 6/22/1999 | S | 1 | 24.4 | 7.19 | 7.19 | | | | 1.1 |
| 2-JMS099.30 | 6/22/1999 | M | 3 | 24.28 | | 7.03 | | | | |
| 2-JMS099.30 | 6/22/1999 | M | 5 | 23.77 | | 6.46 | | | | |
| 2-JMS099.30 | 6/22/1999 | M | 7 | 23.73 | | 6.44 | | | | |
| 2-JMS099.30 | 7/7/1999 | S | 0.3 | 34.67 | 8.05 | 7.89 | | | | |
| 2-JMS099.30 | 7/20/1999 | S | 1 | 30.36 | 8.3 | 10.42 | | | | 1 |
| 2-JMS099.30 | 7/20/1999 | M | 3 | 29.94 | | 9.71 | | | | |
| 2-JMS099.30 | 7/20/1999 | M | 5 | 29.5 | | 9.03 | | | | |
| 2-JMS099.30 | 7/20/1999 | M | 7 | 29.16 | | 8.62 | | | | |
| 2-JMS099.30 | 7/20/1999 | B | 8 | 29.15 | 7.75 | 8.6 | | | | |
| 2-JMS099.30 | 7/21/1999 | S | 0.3 | 31.57 | 7.95 | 7.95 | | | | |
| 2-JMS099.30 | 8/10/1999 | S | 0.3 | 31.8 | 7.89 | 7.05 | | | | |
| 2-JMS099.30 | 8/17/1999 | S | 1 | 31.36 | 8.06 | 9.14 | | | 0.2 | 0.8 |
| 2-JMS099.30 | 8/17/1999 | M | 3 | 30.57 | | 7.92 | | | 0.2 | |
| 2-JMS099.30 | 8/17/1999 | M | 5 | 30.31 | | 7.3 | | | 0.2 | |
| 2-JMS099.30 | 8/17/1999 | M | 7 | 30.17 | | 7.32 | | | 0.2 | |
| 2-JMS099.30 | 8/17/1999 | B | 9 | 30.15 | 7.53 | 7.1 | | | 0.2 | |
| 2-JMS099.30 | 8/31/1999 | S | 0.3 | 26.84 | 7.61 | 7.13 | | | 0 | |
| 2-JMS099.30 | 9/13/1999 | S | 0.3 | 25.57 | 7.63 | 7.62 | | | | |
| 2-JMS099.30 | 9/21/1999 | S | 1 | 21.11 | 7.03 | 8.6 | | | 0 | |
| 2-JMS099.30 | 9/21/1999 | M | 3 | 21.04 | | 8.62 | | | 0 | |
| 2-JMS099.30 | 9/21/1999 | M | 5 | 21.02 | | 8.61 | | | 0 | |
| 2-JMS099.30 | 9/21/1999 | M | 7 | 21.02 | | 8.61 | | | 0 | |
| 2-JMS099.30 | 9/21/1999 | M | 9 | 21.02 | | 8.61 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 9/21/1999 | B | 11 | 21.02 | 7.02 | 8.61 | | | 0 | |
| 2-JMS099.30 | 9/29/1999 | S | 0.3 | 22.15 | 7.28 | 8.3 | | | 0 | |
| 2-JMS099.30 | 10/13/1999 | S | 0.3 | 18.98 | 7.41 | 8.79 | | | 0 | |
| 2-JMS099.30 | 10/26/1999 | S | 0.3 | 13.98 | 7.54 | 10 | | | 0 | |
| 2-JMS099.30 | 10/28/1999 | B | 9 | 13.89 | 7.61 | 9.3 | | | 0.1 | |
| 2-JMS099.30 | 10/28/1999 | S | 1 | 13.89 | 7.64 | 14.24 | | | 0.1 | 1.4 |
| 2-JMS099.30 | 10/28/1999 | M | 3 | 13.96 | | 9.41 | | | 0.1 | |
| 2-JMS099.30 | 10/28/1999 | M | 5 | 13.84 | | 9.43 | | | 0.1 | |
| 2-JMS099.30 | 10/28/1999 | M | 7 | 13.8 | | 9.36 | | | 0.1 | |
| 2-JMS099.30 | 11/18/1999 | S | 1 | | | | | | | |
| 2-JMS099.30 | 11/18/1999 | M | 3 | 11.69 | | 9.75 | | | 0.1 | |
| 2-JMS099.30 | 11/18/1999 | M | 5 | 11.63 | | 9.7 | | | 0.1 | |
| 2-JMS099.30 | 11/18/1999 | M | 7 | 11.63 | | 9.77 | | | 0.1 | |
| 2-JMS099.30 | 11/18/1999 | M | 9 | 11.61 | | 9.72 | | | 0.1 | |
| 2-JMS099.30 | 11/18/1999 | B | 10 | 11.62 | 7.68 | 9.78 | | | 0.1 | |
| 2-JMS099.30 | 11/18/1999 | S | 1 | | | | | | | |
| 2-JMS099.30 | 11/18/1999 | S | 1 | | | | | | | |
| 2-JMS099.30 | 11/18/1999 | S | 1 | | | | | | | |
| 2-JMS099.30 | 11/18/1999 | S | 1 | | | | | | | |
| 2-JMS099.30 | 11/18/1999 | S | 1 | | | | | | | |
| 2-JMS099.30 | 11/18/1999 | S | 1 | | | | | | | |
| 2-JMS099.30 | 11/18/1999 | S | 1 | | | | | | | |
| 2-JMS099.30 | 11/18/1999 | S | 1 | | | | | | | |
| 2-JMS099.30 | 11/18/1999 | S | 1 | | | | | | | |
| 2-JMS099.30 | 11/18/1999 | S | 1 | 11.8 | 7.7 | 9.8 | | | 0.1 | 1.8 |
| 2-JMS099.30 | 12/21/1999 | B | 7 | 7.23 | 7.35 | 11.43 | | | 0 | |
| 2-JMS099.30 | 12/21/1999 | S | 1 | 7.27 | 7.36 | 11.55 | | | 0 | 0.7 |
| 2-JMS099.30 | 12/21/1999 | M | 3 | 7.27 | | 11.63 | | | 0 | |
| 2-JMS099.30 | 12/21/1999 | M | 5 | 7.27 | | 11.71 | | | 0 | |
| 2-JMS099.30 | 12/21/1999 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 12/21/1999 | B | 0.5 | | | | | | | |
| 2-JMS099.30 | 1/18/2000 | B | 10 | 4.08 | 7.36 | 12.94 | | | 0 | |
| 2-JMS099.30 | 1/18/2000 | S | 1 | | | | | | | |
| 2-JMS099.30 | 1/18/2000 | M | 3 | 4.07 | | 12.36 | | | 0 | |
| 2-JMS099.30 | 1/18/2000 | M | 5 | 4.08 | | 12.45 | | | 0 | |
| 2-JMS099.30 | 1/18/2000 | M | 7 | 4.07 | | 12.66 | | | 0 | |
| 2-JMS099.30 | 1/18/2000 | M | 9 | 4.07 | | 12.72 | | | 0 | |
| 2-JMS099.30 | 1/18/2000 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 1/18/2000 | B | 0.5 | | | | | | | |
| 2-JMS099.30 | 2/23/2000 | B | 11 | 7.33 | 7.35 | 11.97 | | | 0 | |
| 2-JMS099.30 | 2/23/2000 | S | 1 | 7.35 | 7.45 | 11.93 | | | 0 | 0.4 |
| 2-JMS099.30 | 2/23/2000 | M | 3 | 7.33 | | 11.93 | | | 0 | |
| 2-JMS099.30 | 2/23/2000 | M | 5 | 7.33 | | 11.95 | | | 0 | |
| 2-JMS099.30 | 2/23/2000 | M | 7 | 7.32 | | 11.97 | | | 0 | |
| 2-JMS099.30 | 2/23/2000 | M | 9 | 7.32 | | 11.99 | | | 0 | |
| 2-JMS099.30 | 3/28/2000 | B | 10 | 14.01 | 7.27 | 9.49 | | | 0 | |
| 2-JMS099.30 | 3/28/2000 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 3/28/2000 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 3/28/2000 | S | 1 | 14.02 | 7.32 | 9.54 | | | 0 | 0.8 |
| 2-JMS099.30 | 3/28/2000 | M | 1 | | | | | | | |
| 2-JMS099.30 | 3/28/2000 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 3/28/2000 | B | 2 | | | | | | | |
| 2-JMS099.30 | 3/28/2000 | M | 3 | 14 | | 9.52 | | | 0 | |
| 2-JMS099.30 | 3/28/2000 | M | 5 | 14 | | 9.49 | | | 0 | |
| 2-JMS099.30 | 3/28/2000 | M | 7 | 14 | | 9.49 | | | 0 | |
| 2-JMS099.30 | 3/28/2000 | M | 9 | 13.99 | | 9.48 | | | 0 | |
| 2-JMS099.30 | 4/24/2000 | B | 12 | 16.31 | 7.18 | 9.22 | | | 0 | |
| 2-JMS099.30 | 4/24/2000 | S | 1 | 16.32 | 7.26 | 9.15 | | | 0 | 0.5 |
| 2-JMS099.30 | 4/24/2000 | M | 3 | 16.31 | | 9.14 | | | 0 | |
| 2-JMS099.30 | 4/24/2000 | M | 5 | 16.32 | | 9.14 | | | 0 | |
| 2-JMS099.30 | 4/24/2000 | M | 7 | 16.33 | | 9.18 | | | 0 | |
| 2-JMS099.30 | 4/24/2000 | M | 9 | 16.33 | | 9.15 | | | 0 | |
| 2-JMS099.30 | 4/24/2000 | M | 11 | 16.33 | | 9.23 | | | 0 | |
| 2-JMS099.30 | 4/24/2000 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 4/24/2000 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 4/24/2000 | M | 1 | | | | | | | |
| 2-JMS099.30 | 4/24/2000 | B | 1.5 | | | | | | | |
| 2-JMS099.30 | 5/1/2000 | S | 0.3 | 17.49 | 7.48 | 9.44 | | | 0 | |
| 2-JMS099.30 | 5/22/2000 | S | 0.3 | 24.1 | 7.12 | 6 | | | 0 | |
| 2-JMS099.30 | 5/23/2000 | B | 7 | 23.2 | 7.3 | 5.3 | | | 0.1 | |
| 2-JMS099.30 | 5/23/2000 | S | 1 | 23.34 | 7.29 | 6.3 | | | 0.1 | 1 |
| 2-JMS099.30 | 5/23/2000 | M | 3 | 23.3 | | 6.06 | | | 0.1 | |
| 2-JMS099.30 | 5/23/2000 | M | 5 | 23.28 | | 5.6 | | | 0.1 | |
| 2-JMS099.30 | 5/23/2000 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 5/23/2000 | M | 0.5 | | | | | | | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 5/23/2000 | M | 1 | | | | | | | |
| 2-JMS099.30 | 5/23/2000 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 5/23/2000 | M | 2 | | | | | | | |
| 2-JMS099.30 | 5/23/2000 | B | 2.5 | | | | | | | |
| 2-JMS099.30 | 6/5/2000 | S | 0.3 | 24.32 | 7.63 | 7.78 | | | 0 | |
| 2-JMS099.30 | 6/20/2000 | B | 5 | 28.99 | 7.39 | 6.03 | | | 0.1 | |
| 2-JMS099.30 | 6/20/2000 | S | 1 | 29.24 | 7.4 | 5.87 | | | 0.1 | |
| 2-JMS099.30 | 6/20/2000 | M | 3 | 29.08 | | 6.03 | | | 0.1 | |
| 2-JMS099.30 | 6/22/2000 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 6/22/2000 | S | 0.3 | 28.16 | 7.51 | 7.1 | | | 0 | |
| 2-JMS099.30 | 7/11/2000 | S | 0.3 | 30.43 | 8.26 | 8.8 | | | 0 | |
| 2-JMS099.30 | 7/18/2000 | B | 6 | 28.93 | 7.54 | 7.69 | | | 0.1 | |
| 2-JMS099.30 | 7/18/2000 | S | 1 | 30.02 | 7 | 9.42 | | | 0.1 | 0.9 |
| 2-JMS099.30 | 7/18/2000 | M | 3 | 29.01 | | 7.81 | | | 0.1 | |
| 2-JMS099.30 | 7/18/2000 | M | 5 | 28.88 | | 7.71 | | | 0.1 | |
| 2-JMS099.30 | 7/18/2000 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 7/18/2000 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 7/18/2000 | M | 1 | | | | | | | |
| 2-JMS099.30 | 7/18/2000 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 7/18/2000 | B | 2 | | | | | | | |
| 2-JMS099.30 | 7/26/2000 | S | 0.3 | 26.15 | 7.32 | 6.68 | | | 0 | |
| 2-JMS099.30 | 8/7/2000 | S | 0.3 | 28.64 | 7.62 | 7.25 | | | 0 | |
| 2-JMS099.30 | 8/22/2000 | B | 14 | 26.6 | 7.58 | 7.04 | | | 0 | |
| 2-JMS099.30 | 8/22/2000 | S | 1 | 26.86 | 7.76 | 7.54 | | | 0 | 0.6 |
| 2-JMS099.30 | 8/22/2000 | M | 3 | 26.7 | | 7.25 | | | 0 | |
| 2-JMS099.30 | 8/22/2000 | M | 5 | 26.64 | | 7.11 | | | 0 | |
| 2-JMS099.30 | 8/22/2000 | M | 7 | 26.63 | | 7.11 | | | 0 | |
| 2-JMS099.30 | 8/22/2000 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 8/22/2000 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 8/22/2000 | M | 1 | | | | | | | |
| 2-JMS099.30 | 8/22/2000 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 8/22/2000 | M | 2 | | | | | | | |
| 2-JMS099.30 | 8/22/2000 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 8/22/2000 | M | 3 | | | | | | | |
| 2-JMS099.30 | 8/22/2000 | B | 3.5 | | | | | | | |
| 2-JMS099.30 | 8/23/2000 | S | 0.3 | 28.43 | 8.03 | 8.41 | | | | |
| 2-JMS099.30 | 9/13/2000 | S | 0.3 | 25.95 | 7.51 | 7.88 | | | 0 | |
| 2-JMS099.30 | 9/26/2000 | B | 5 | 21.69 | 7.54 | 7.53 | | | 0.1 | |
| 2-JMS099.30 | 9/26/2000 | S | 1 | 21.66 | 7.55 | 7.45 | | | 0.1 | 1.1 |
| 2-JMS099.30 | 9/26/2000 | M | 3 | 21.68 | | 7.66 | | | 0.1 | |
| 2-JMS099.30 | 9/26/2000 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 9/26/2000 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 9/26/2000 | M | 1 | | | | | | | |
| 2-JMS099.30 | 9/26/2000 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 9/26/2000 | B | 2 | | | | | | | |
| 2-JMS099.30 | 10/2/2000 | S | 0.3 | 20.01 | 7.63 | 8.47 | | | 0 | |
| 2-JMS099.30 | 10/16/2000 | S | 0.3 | 17.13 | 7.75 | 8.97 | | | 0 | |
| 2-JMS099.30 | 10/24/2000 | B | 10 | 18.74 | 7.72 | 8.14 | | | 0 | |
| 2-JMS099.30 | 10/24/2000 | S | 1 | 20.05 | | 9.37 | | | 0 | 0.9 |
| 2-JMS099.30 | 10/24/2000 | M | 3 | 18.99 | | 8.37 | | | 0 | |
| 2-JMS099.30 | 10/24/2000 | M | 5 | 18.84 | | 8.21 | | | 0 | |
| 2-JMS099.30 | 10/24/2000 | M | 7 | 18.82 | | 8.34 | | | 0 | |
| 2-JMS099.30 | 10/24/2000 | M | 9 | 18.76 | | 8.25 | | | 0 | |
| 2-JMS099.30 | 10/24/2000 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 10/24/2000 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 10/24/2000 | M | 1 | | | | | | | |
| 2-JMS099.30 | 10/24/2000 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 10/24/2000 | M | 2 | | | | | | | |
| 2-JMS099.30 | 10/24/2000 | B | 2.5 | | | | | | | |
| 2-JMS099.30 | 10/30/2000 | S | 0.3 | 17.5 | 7.55 | 8.22 | | | 0 | |
| 2-JMS099.30 | 11/28/2000 | S | 1 | | | | | | | 1 |
| 2-JMS099.30 | 11/28/2000 | M | 3 | | | | | | | |
| 2-JMS099.30 | 11/28/2000 | M | 5 | | | | | | | |
| 2-JMS099.30 | 11/28/2000 | M | 7 | | | | | | | |
| 2-JMS099.30 | 11/28/2000 | B | 9 | | | | | | | |
| 2-JMS099.30 | 11/28/2000 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 1/23/2001 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 1/23/2001 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 1/23/2001 | S | 1 | 3.16 | 6.98 | 13.55 | | | 0 | 0.3 |
| 2-JMS099.30 | 1/23/2001 | M | 1 | | | | | | | |
| 2-JMS099.30 | 1/23/2001 | B | 1.5 | | | | | | | |
| 2-JMS099.30 | 1/23/2001 | M | 3 | 3.11 | | 13.61 | | | 0 | |
| 2-JMS099.30 | 1/23/2001 | B | 4 | 3.08 | 7 | 13.78 | | | 0 | |
| 2-JMS099.30 | 2/20/2001 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 2/20/2001 | M | 0.5 | | | | | | | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 2/20/2001 | M | 1 | | | | | | | |
| 2-JMS099.30 | 2/20/2001 | S | 1 | 8.52 | 7.49 | 11.53 | | | 0.1 | 0.8 |
| 2-JMS099.30 | 2/20/2001 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 2/20/2001 | M | 2 | | | | | | | |
| 2-JMS099.30 | 2/20/2001 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 2/20/2001 | B | 3 | | | | | | | |
| 2-JMS099.30 | 2/20/2001 | M | 3 | 8.26 | | 11.53 | | | 0.1 | |
| 2-JMS099.30 | 2/20/2001 | M | 5 | 8.11 | | 11.51 | | | 0.1 | |
| 2-JMS099.30 | 2/20/2001 | M | 7 | 7.98 | | 11.52 | | | 0.1 | |
| 2-JMS099.30 | 2/20/2001 | M | 9 | 7.76 | | 11.43 | | | 0.1 | |
| 2-JMS099.30 | 2/20/2001 | B | 10 | 7.96 | 7.6 | 11.56 | | | 0.1 | |
| 2-JMS099.30 | 3/27/2001 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 3/27/2001 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 3/27/2001 | S | 1 | 9.31 | 6.86 | 12.18 | | | 0.1 | 0.5 |
| 2-JMS099.30 | 3/27/2001 | M | 1 | | | | | | | |
| 2-JMS099.30 | 3/27/2001 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 3/27/2001 | B | 2 | | | | | | | |
| 2-JMS099.30 | 3/27/2001 | M | 3 | 9.28 | | 12.26 | | | 0.1 | |
| 2-JMS099.30 | 3/27/2001 | M | 5 | 9.21 | | 12.28 | | | 0.1 | |
| 2-JMS099.30 | 3/27/2001 | M | 7 | 9 | | 12.36 | | | 0.1 | |
| 2-JMS099.30 | 3/27/2001 | B | 8 | 8.98 | 6.67 | 12.6 | | | 0.1 | |
| 2-JMS099.30 | 4/24/2001 | S | 1 | 19.57 | 7.97 | 9.63 | | | 0 | 0.7 |
| 2-JMS099.30 | 4/24/2001 | M | 3 | 19.44 | | 9.37 | | | 0 | |
| 2-JMS099.30 | 4/24/2001 | M | 5 | 19.44 | | 9.33 | | | 0 | |
| 2-JMS099.30 | 4/24/2001 | M | 7 | 19.42 | | 9.36 | | | 0 | |
| 2-JMS099.30 | 4/24/2001 | M | 9 | 19.4 | | 9.31 | | | 0 | |
| 2-JMS099.30 | 4/24/2001 | B | 10 | 19.4 | 7.9 | 9.39 | | | 0 | |
| 2-JMS099.30 | 4/24/2001 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 4/24/2001 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 4/24/2001 | M | 1 | | | | | | | |
| 2-JMS099.30 | 4/24/2001 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 4/24/2001 | M | 2 | | | | | | | |
| 2-JMS099.30 | 4/24/2001 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 4/24/2001 | B | 3 | | | | | | | |
| 2-JMS099.30 | 5/7/2001 | S | 0.3 | 24.21 | 8.64 | 10.31 | | | | |
| 2-JMS099.30 | 5/30/2001 | S | 0.3 | 19.2 | 7.4 | 9.1 | | | | |
| 2-JMS099.30 | 6/13/2001 | S | 0.3 | 28.02 | 8.43 | 9.47 | | | 0 | |
| 2-JMS099.30 | 6/19/2001 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 6/19/2001 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 6/19/2001 | S | 1 | 28.43 | 8.28 | 9.14 | | | 0.1 | 0.8 |
| 2-JMS099.30 | 6/19/2001 | M | 1 | | | | | | | |
| 2-JMS099.30 | 6/19/2001 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 6/19/2001 | M | 2 | | | | | | | |
| 2-JMS099.30 | 6/19/2001 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 6/19/2001 | M | 3 | 27.82 | | 8.06 | | | 0.1 | |
| 2-JMS099.30 | 6/19/2001 | B | 3.5 | | | | | | | |
| 2-JMS099.30 | 6/19/2001 | M | 5 | 27.57 | | 7.83 | | | 0.1 | |
| 2-JMS099.30 | 6/19/2001 | M | 7 | 27.49 | | 7.66 | | | 0.1 | |
| 2-JMS099.30 | 6/19/2001 | B | 8 | 27.49 | 7.67 | 7.66 | | | 0.1 | |
| 2-JMS099.30 | 6/28/2001 | S | 0.3 | 29.79 | 7.5 | 7.84 | | | | |
| 2-JMS099.30 | 7/5/2001 | S | 0.3 | 28.96 | 6.82 | 5.38 | | | | |
| 2-JMS099.30 | 7/24/2001 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 7/24/2001 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 7/24/2001 | S | 1 | 28.29 | 7.33 | 7.34 | | | 0 | 0.8 |
| 2-JMS099.30 | 7/24/2001 | M | 1 | | | | | | | |
| 2-JMS099.30 | 7/24/2001 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 7/24/2001 | M | 2 | | | | | | | |
| 2-JMS099.30 | 7/24/2001 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 7/24/2001 | M | 3 | 28.03 | 7.27 | 7.06 | | | 0 | |
| 2-JMS099.30 | 7/24/2001 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 7/24/2001 | B | 4 | | | | | | | |
| 2-JMS099.30 | 7/24/2001 | M | 5 | 27.84 | 7.29 | 6.68 | | | 0 | |
| 2-JMS099.30 | 7/24/2001 | M | 7 | 27.73 | 7.23 | 6.94 | | | 0 | |
| 2-JMS099.30 | 7/24/2001 | B | 8 | 27.61 | 7.19 | 6.85 | | | 0 | |
| 2-JMS099.30 | 7/30/2001 | S | 0.3 | 26.8 | 7.17 | 6.06 | | | | |
| 2-JMS099.30 | 8/6/2001 | S | 0.3 | 28.46 | 7.94 | 7.52 | | | | |
| 2-JMS099.30 | 8/21/2001 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 8/21/2001 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 8/21/2001 | S | 1 | 27.65 | 7.49 | 6.64 | | | 0 | 0.7 |
| 2-JMS099.30 | 8/21/2001 | M | 1 | | | | | | | |
| 2-JMS099.30 | 8/21/2001 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 8/21/2001 | B | 2 | | | | | | | |
| 2-JMS099.30 | 8/21/2001 | M | 3 | 29.54 | | 6.83 | | | 0 | |
| 2-JMS099.30 | 8/21/2001 | M | 5 | 29.53 | | 6.66 | | | 0 | |
| 2-JMS099.30 | 8/21/2001 | M | 7 | 29.51 | | 6.59 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 8/21/2001 | M | 9 | 29.46 | | 6.5 | | | 0 | |
| 2-JMS099.30 | 8/21/2001 | B | 10 | 29.43 | 7.47 | 6.42 | | | 0 | |
| 2-JMS099.30 | 8/23/2001 | S | 0.3 | 29.21 | 7.36 | 6.15 | | | | |
| 2-JMS099.30 | 9/18/2001 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 9/18/2001 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 9/18/2001 | M | 1 | | | | | | | |
| 2-JMS099.30 | 9/18/2001 | S | 1 | 27.25 | 8.1 | 8.02 | | | 0.3 | 0.9 |
| 2-JMS099.30 | 9/18/2001 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 9/18/2001 | M | 2 | | | | | | | |
| 2-JMS099.30 | 9/18/2001 | M | 3 | 26.4 | | 7.35 | | | 0.3 | |
| 2-JMS099.30 | 9/18/2001 | M | 5 | 26.04 | | 8.03 | | | 0.2 | |
| 2-JMS099.30 | 9/18/2001 | M | 7 | 25.72 | | 7.89 | | | 0.2 | |
| 2-JMS099.30 | 9/18/2001 | M | 9 | 25.61 | | 7.32 | | | 0.2 | |
| 2-JMS099.30 | 9/18/2001 | B | 10 | 25.51 | 7.88 | 7.52 | | | 0.2 | |
| 2-JMS099.30 | 10/16/2001 | S | 0 | | | | | | | |
| 2-JMS099.30 | 10/16/2001 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 10/16/2001 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 10/16/2001 | M | 1 | | | | | | | |
| 2-JMS099.30 | 10/16/2001 | S | 1 | 22.64 | 8.16 | 9.43 | | | 0.3 | 0.6 |
| 2-JMS099.30 | 10/16/2001 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 10/16/2001 | M | 2 | | | | | | | |
| 2-JMS099.30 | 10/16/2001 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 10/16/2001 | M | 3 | 22.01 | | 8.92 | | | 0.3 | |
| 2-JMS099.30 | 10/16/2001 | M | 5 | 21.62 | | 8.63 | | | 0.3 | |
| 2-JMS099.30 | 10/16/2001 | M | 7 | 21.32 | | 8.61 | | | 0.3 | |
| 2-JMS099.30 | 10/16/2001 | M | 9 | 21.25 | | 8.57 | | | 0.3 | |
| 2-JMS099.30 | 10/16/2001 | M | 11 | 21.18 | | 8.55 | | | 0.3 | |
| 2-JMS099.30 | 10/16/2001 | B | 12 | 21.18 | 7.89 | 8.58 | | | 0.3 | |
| 2-JMS099.30 | 11/27/2001 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 11/27/2001 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 11/27/2001 | B | 1 | | | | | | | |
| 2-JMS099.30 | 11/27/2001 | S | 1 | 15.22 | 7.67 | 8.96 | | | 0 | 0.9 |
| 2-JMS099.30 | 11/27/2001 | M | 3 | 14.24 | | 8.84 | | | 0 | |
| 2-JMS099.30 | 11/27/2001 | M | 5 | 14.03 | | 9 | | | 0 | |
| 2-JMS099.30 | 11/27/2001 | M | 7 | 13.55 | | 9.12 | | | 0 | |
| 2-JMS099.30 | 11/27/2001 | M | 9 | 13.46 | | 9.3 | | | 0 | |
| 2-JMS099.30 | 11/27/2001 | B | 10 | 13.44 | 7.65 | 9.4 | | | 0 | |
| 2-JMS099.30 | 12/12/2001 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 12/12/2001 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 12/12/2001 | B | 1 | | | | | | | |
| 2-JMS099.30 | 12/12/2001 | S | 1 | 15.3 | 7.43 | 8.4 | | | 0 | 1 |
| 2-JMS099.30 | 12/12/2001 | M | 3 | 13.68 | | 8.6 | | | 0 | |
| 2-JMS099.30 | 12/12/2001 | M | 5 | 13.41 | | 8.78 | | | 0 | |
| 2-JMS099.30 | 12/12/2001 | M | 7 | 13.51 | | 8.93 | | | 0.2 | |
| 2-JMS099.30 | 12/12/2001 | B | 9 | 13.38 | 7.34 | 9.23 | | | 0.2 | |
| 2-JMS099.30 | 1/22/2002 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 1/22/2002 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 1/22/2002 | S | 1 | 6.11 | 7.54 | 11.98 | | | 0 | 1.7 |
| 2-JMS099.30 | 1/22/2002 | M | 1 | | | | | | | |
| 2-JMS099.30 | 1/22/2002 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 1/22/2002 | M | 2 | | | | | | | |
| 2-JMS099.30 | 1/22/2002 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 1/22/2002 | M | 3 | 6.14 | | 12.02 | | | 0 | |
| 2-JMS099.30 | 1/22/2002 | B | 3.5 | | | | | | | |
| 2-JMS099.30 | 1/22/2002 | M | 5 | 6.06 | | 12.04 | | | 0 | |
| 2-JMS099.30 | 1/22/2002 | M | 7 | 6.05 | | 12.09 | | | 0 | |
| 2-JMS099.30 | 1/22/2002 | M | 9 | 5.98 | | 12.3 | | | 0 | |
| 2-JMS099.30 | 1/22/2002 | B | 11 | 6.01 | 7.14 | 12.9 | | | 0 | |
| 2-JMS099.30 | 2/19/2002 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 2/19/2002 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 2/19/2002 | S | 1 | 8.05 | 7.61 | 11.05 | | | 0.14 | 1.5 |
| 2-JMS099.30 | 2/19/2002 | M | 1 | | | | | | | |
| 2-JMS099.30 | 2/19/2002 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 2/19/2002 | M | 2 | | | | | | | |
| 2-JMS099.30 | 2/19/2002 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 2/19/2002 | M | 3 | 7.64 | | 11.06 | | | 0.13 | |
| 2-JMS099.30 | 2/19/2002 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 2/19/2002 | B | 4 | | | | | | | |
| 2-JMS099.30 | 2/19/2002 | M | 5 | 7.66 | | 11.28 | | | 0.13 | |
| 2-JMS099.30 | 2/19/2002 | M | 7 | 7.68 | | 11.17 | | | 0.14 | |
| 2-JMS099.30 | 2/19/2002 | M | 9 | 7.68 | | 11.09 | | | 0.14 | |
| 2-JMS099.30 | 2/19/2002 | M | 11 | 7.69 | | 11.19 | | | 0.14 | |
| 2-JMS099.30 | 2/19/2002 | B | 12 | 7.68 | 7.51 | 11.28 | | | 0.13 | |
| 2-JMS099.30 | 3/19/2002 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 3/19/2002 | M | 0.5 | | | | | | | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 3/19/2002 | B | 1 | | | | | | | |
| 2-JMS099.30 | 3/19/2002 | S | 1 | 13.4 | 7.54 | 8.27 | | | 0.15 | 1 |
| 2-JMS099.30 | 3/19/2002 | M | 3 | 13.39 | | 8.48 | | | 0.15 | |
| 2-JMS099.30 | 3/19/2002 | M | 5 | 13.34 | | 8.28 | | | 0.15 | |
| 2-JMS099.30 | 3/19/2002 | M | 7 | 13.29 | | 8.3 | | | 0.15 | |
| 2-JMS099.30 | 3/19/2002 | M | 9 | 13.28 | | 8.27 | | | 0.15 | |
| 2-JMS099.30 | 3/19/2002 | M | 11 | 13.27 | | 8.36 | | | 0.15 | |
| 2-JMS099.30 | 3/19/2002 | B | 12 | 13.26 | 7.5 | 8.19 | | | 0.15 | |
| 2-JMS099.30 | 4/16/2002 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 4/16/2002 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 4/16/2002 | S | 1 | 21.7 | 7.4 | 7.91 | | | 0.8 | 1.5 |
| 2-JMS099.30 | 4/16/2002 | M | 1 | | | | | | | |
| 2-JMS099.30 | 4/16/2002 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 4/16/2002 | M | 2 | | | | | | | |
| 2-JMS099.30 | 4/16/2002 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 4/16/2002 | M | 3 | 21.21 | | 7.79 | | | 0.8 | |
| 2-JMS099.30 | 4/16/2002 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 4/16/2002 | M | 4 | | | | | | | |
| 2-JMS099.30 | 4/16/2002 | B | 4.5 | | | | | | | |
| 2-JMS099.30 | 4/16/2002 | M | 5 | 21.05 | | 7.81 | | | 0.8 | |
| 2-JMS099.30 | 4/16/2002 | M | 7 | 20.86 | | 7.79 | | | 0.8 | |
| 2-JMS099.30 | 4/16/2002 | B | 8 | 20.78 | 7.35 | 7.68 | | | 0.8 | |
| 2-JMS099.30 | 5/30/2002 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 5/30/2002 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 5/30/2002 | S | 1 | 26.41 | 8.19 | 8.12 | | | 0 | 0.9 |
| 2-JMS099.30 | 5/30/2002 | M | 1 | | | | | | | |
| 2-JMS099.30 | 5/30/2002 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 5/30/2002 | M | 2 | | | | | | | |
| 2-JMS099.30 | 5/30/2002 | B | 2.5 | | | | | | | |
| 2-JMS099.30 | 5/30/2002 | M | 3 | 26.01 | 7.99 | 7.67 | | | 0 | |
| 2-JMS099.30 | 5/30/2002 | M | 5 | 25.44 | 7.74 | 7.25 | | | 0 | |
| 2-JMS099.30 | 5/30/2002 | M | 7 | 25.31 | 7.6 | 6.54 | | | 0 | |
| 2-JMS099.30 | 5/30/2002 | M | 9 | 25.32 | 7.52 | 6.53 | | | 0 | |
| 2-JMS099.30 | 5/30/2002 | B | 10 | 25.31 | 7.48 | 6.43 | | | 0 | |
| 2-JMS099.30 | 6/25/2002 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 6/25/2002 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 6/25/2002 | M | 1 | | | | | | | |
| 2-JMS099.30 | 6/25/2002 | S | 1 | 31.26 | 8.19 | | | | 0 | 0.4 |
| 2-JMS099.30 | 6/25/2002 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 6/25/2002 | B | 2 | | | | | | | |
| 2-JMS099.30 | 6/25/2002 | M | 3 | 30.54 | 7.94 | | | | 0 | |
| 2-JMS099.30 | 6/25/2002 | M | 5 | 30.51 | 7.94 | | | | 0 | |
| 2-JMS099.30 | 6/25/2002 | M | 7 | 30.33 | 7.89 | | | | 0 | |
| 2-JMS099.30 | 6/25/2002 | M | 9 | 29.94 | 7.81 | | | | 0 | |
| 2-JMS099.30 | 6/25/2002 | B | 10 | 29.94 | 7.73 | | | | 0 | |
| 2-JMS099.30 | 7/23/2002 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 7/23/2002 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 7/23/2002 | M | 1 | | | | | | | |
| 2-JMS099.30 | 7/23/2002 | S | 1 | 32.08 | 7.86 | 7.89 | | | 0 | 0.9 |
| 2-JMS099.30 | 7/23/2002 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 7/23/2002 | M | 2 | | | | | | | |
| 2-JMS099.30 | 7/23/2002 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 7/23/2002 | M | 3 | 31.05 | 7.64 | 6.8 | | | 0 | |
| 2-JMS099.30 | 7/23/2002 | B | 3 | | | | | | | |
| 2-JMS099.30 | 7/23/2002 | M | 5 | 30.94 | 7.62 | 6.77 | | | 0 | |
| 2-JMS099.30 | 7/23/2002 | M | 7 | 30.7 | 7.56 | 6.68 | | | 0 | |
| 2-JMS099.30 | 7/23/2002 | M | 9 | 30.68 | 7.59 | 6.69 | | | 0 | |
| 2-JMS099.30 | 7/23/2002 | M | 11 | 30.74 | 7.58 | 4.35 | | | 0 | |
| 2-JMS099.30 | 7/23/2002 | B | 12 | 30.6 | 7.2 | 4.35 | | | 0 | |
| 2-JMS099.30 | 8/13/2002 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 8/13/2002 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 8/13/2002 | S | 1 | 30.51 | 7.92 | 7.55 | | | 0 | 0.9 |
| 2-JMS099.30 | 8/13/2002 | M | 1 | | | | | | | |
| 2-JMS099.30 | 8/13/2002 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 8/13/2002 | M | 2 | | | | | | | |
| 2-JMS099.30 | 8/13/2002 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 8/13/2002 | M | 3 | 30.11 | 7.81 | 7.14 | | | 0 | |
| 2-JMS099.30 | 8/13/2002 | B | 3.5 | | | | | | | |
| 2-JMS099.30 | 8/13/2002 | M | 5 | 29.67 | 7.68 | 6.73 | | | 0 | |
| 2-JMS099.30 | 8/13/2002 | M | 7 | 29.64 | 7.69 | 6.76 | | | 0 | |
| 2-JMS099.30 | 8/13/2002 | M | 9 | 29.62 | 7.68 | 6.85 | | | 0 | |
| 2-JMS099.30 | 8/13/2002 | B | 11 | 29.64 | 7.69 | 6.86 | | | 0 | |
| 2-JMS099.30 | 9/24/2002 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 9/24/2002 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 9/24/2002 | M | 1 | | | | | | | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 9/24/2002 | S | 1 | 28.76 | 7.85 | 7.76 | | | 0 | 0.8 |
| 2-JMS099.30 | 9/24/2002 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 9/24/2002 | B | 2 | | | | | | | |
| 2-JMS099.30 | 9/24/2002 | M | 3 | 28.19 | 7.45 | 6.34 | | | 0 | |
| 2-JMS099.30 | 9/24/2002 | M | 5 | 28.06 | 7.38 | 6.26 | | | 0 | |
| 2-JMS099.30 | 9/24/2002 | M | 7 | 27.92 | 7.37 | 6.36 | | | 0 | |
| 2-JMS099.30 | 9/24/2002 | B | 9 | 27.75 | 7.37 | 6.61 | | | 0 | |
| 2-JMS099.30 | 10/22/2002 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 10/22/2002 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 10/22/2002 | M | 1 | | | | | | | |
| 2-JMS099.30 | 10/22/2002 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 10/22/2002 | M | 2 | | | | | | | |
| 2-JMS099.30 | 10/22/2002 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 10/22/2002 | M | 3 | | | | | | | |
| 2-JMS099.30 | 10/22/2002 | B | 3.5 | | | | | | | |
| 2-JMS099.30 | 10/22/2002 | S | 1 | 17.65 | 7.8 | 7.65 | | | 0 | 1.5 |
| 2-JMS099.30 | 10/22/2002 | M | 3 | 17.68 | 7.77 | 7.68 | | | 0 | |
| 2-JMS099.30 | 10/22/2002 | M | 5 | 17.33 | 7.78 | 7.5 | | | 0 | |
| 2-JMS099.30 | 10/22/2002 | M | 7 | 17.39 | 7.79 | 7.31 | | | 0 | |
| 2-JMS099.30 | 10/22/2002 | M | 9 | 17.34 | 7.8 | 7.44 | | | 0 | |
| 2-JMS099.30 | 10/22/2002 | B | 10 | 17.3 | 7.8 | 7.61 | | | 0 | |
| 2-JMS099.30 | 11/19/2002 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 11/19/2002 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 11/19/2002 | B | 1 | | | | | | | |
| 2-JMS099.30 | 11/19/2002 | S | 1 | 10.01 | 7.05 | 12.35 | | | 0 | 0.4 |
| 2-JMS099.30 | 11/19/2002 | M | 3 | 10.01 | 7.06 | 11.65 | | | 0 | |
| 2-JMS099.30 | 11/19/2002 | M | 5 | 10.01 | 7.05 | 12.32 | | | 0 | |
| 2-JMS099.30 | 11/19/2002 | M | 7 | 10.01 | 7.05 | 13.17 | | | 0 | |
| 2-JMS099.30 | 11/19/2002 | M | 9 | 10.03 | 7.05 | 11.83 | | | 0 | |
| 2-JMS099.30 | 11/19/2002 | B | 10 | 10.03 | 7.05 | 12.04 | | | 0 | |
| 2-JMS099.30 | 12/10/2002 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 12/10/2002 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 12/10/2002 | M | 1 | | | | | | | |
| 2-JMS099.30 | 12/10/2002 | S | 1 | 2.53 | 7.46 | 14.38 | | | 0 | 2.5 |
| 2-JMS099.30 | 12/10/2002 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 12/10/2002 | B | 2 | | | | | | | |
| 2-JMS099.30 | 12/10/2002 | M | 3 | 2.53 | 7.46 | 15.45 | | | 0 | |
| 2-JMS099.30 | 12/10/2002 | M | 5 | 2.52 | 7.45 | 14.58 | | | 0 | |
| 2-JMS099.30 | 12/10/2002 | M | 7 | 2.53 | 7.46 | 15.41 | | | 0 | |
| 2-JMS099.30 | 12/10/2002 | B | 9 | 2.54 | 7.46 | 14.97 | | | 0 | |
| 2-JMS099.30 | 1/21/2003 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 1/21/2003 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 1/21/2003 | M | 1 | | | | | | | |
| 2-JMS099.30 | 1/21/2003 | S | 1 | 1.48 | 7.68 | 15.03 | | | 0 | 1.4 |
| 2-JMS099.30 | 1/21/2003 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 1/21/2003 | M | 2 | | | | | | | |
| 2-JMS099.30 | 1/21/2003 | B | 2.5 | | | | | | | |
| 2-JMS099.30 | 1/21/2003 | M | 3 | 1.48 | 7.55 | 15.18 | | | 0 | |
| 2-JMS099.30 | 1/21/2003 | M | 5 | 1.49 | 7.6 | 14.98 | | | 0 | |
| 2-JMS099.30 | 1/21/2003 | M | 7 | 1.49 | 7.56 | 15.37 | | | 0 | |
| 2-JMS099.30 | 1/21/2003 | B | 9 | 1.49 | 7.54 | 15.14 | | | 0 | |
| 2-JMS099.30 | 2/25/2003 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 2/25/2003 | S | 1 | 4.46 | 6.8 | 12.9 | | | 0 | 0.1 |
| 2-JMS099.30 | 2/25/2003 | M | 2 | 4.46 | 6.81 | 12.79 | | | 0 | |
| 2-JMS099.30 | 2/25/2003 | M | 3 | 4.46 | 6.72 | 12.79 | | | 0 | |
| 2-JMS099.30 | 2/25/2003 | M | 4 | 4.46 | 6.96 | 12.69 | | | 0 | |
| 2-JMS099.30 | 2/25/2003 | B | 5 | 4.46 | 6.85 | 12.67 | | | 0 | |
| 2-JMS099.30 | 3/18/2003 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 3/18/2003 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 3/18/2003 | S | 1 | 11.73 | 7.8 | 10.35 | | | 0 | 0.1 |
| 2-JMS099.30 | 3/18/2003 | M | 1 | | | | | | | |
| 2-JMS099.30 | 3/18/2003 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 3/18/2003 | M | 2 | | | | | | | |
| 2-JMS099.30 | 3/18/2003 | M | 3 | 11.47 | 7.77 | 10.8 | | | 0 | |
| 2-JMS099.30 | 3/18/2003 | M | 5 | 11.27 | 7.75 | 10.63 | | | 0 | |
| 2-JMS099.30 | 3/18/2003 | M | 7 | 11.45 | 7.75 | 10.85 | | | 0 | |
| 2-JMS099.30 | 3/18/2003 | M | 9 | 11.31 | 7.74 | 10.95 | | | 0 | |
| 2-JMS099.30 | 3/18/2003 | M | 11 | 11.23 | 7.74 | 10.96 | | | 0 | |
| 2-JMS099.30 | 3/18/2003 | B | 12 | 11.2 | 7.74 | 10.98 | | | 0 | |
| 2-JMS099.30 | 4/15/2003 | S | 1 | 13.31 | 6.86 | 11.27 | | | 0 | |
| 2-JMS099.30 | 4/15/2003 | B | 3 | 13.4 | 7.35 | 11.23 | | | 0 | |
| 2-JMS099.30 | 5/27/2003 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 5/27/2003 | S | 1 | 17.21 | 6.9 | 9.37 | | | 0 | 0.5 |
| 2-JMS099.30 | 5/27/2003 | M | 3 | 17.32 | 6.85 | 9.36 | | | 0 | |
| 2-JMS099.30 | 5/27/2003 | M | 5 | 17.22 | 6.94 | 9 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 5/27/2003 | B | 6 | 17.22 | 6.96 | 9.04 | | | 0 | |
| 2-JMS099.30 | 6/24/2003 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 6/24/2003 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 6/24/2003 | S | 1 | 21.07 | 7.59 | 8.35 | | | 0 | 0.6 |
| 2-JMS099.30 | 6/24/2003 | M | 1 | | | | | | | |
| 2-JMS099.30 | 6/24/2003 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 6/24/2003 | M | 2 | | | | | | | |
| 2-JMS099.30 | 6/24/2003 | M | 3 | 21.04 | 7.58 | 8.36 | | | 0 | |
| 2-JMS099.30 | 6/24/2003 | M | 5 | 21.03 | 7.58 | 8.37 | | | 0 | |
| 2-JMS099.30 | 6/24/2003 | M | 7 | 21.07 | 7.57 | 8.43 | | | 0 | |
| 2-JMS099.30 | 6/24/2003 | M | 9 | 21.06 | 7.57 | 8.55 | | | 0 | |
| 2-JMS099.30 | 6/24/2003 | M | 11 | 21.07 | 7.58 | 8.67 | | | 0 | |
| 2-JMS099.30 | 6/24/2003 | B | 12 | 21.06 | 7.58 | 8.66 | | | 0 | |
| 2-JMS099.30 | 7/15/2003 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 7/15/2003 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 7/15/2003 | S | 1 | 27.76 | 8.25 | 8.89 | | | 0 | 0.6 |
| 2-JMS099.30 | 7/15/2003 | M | 1 | | | | | | | |
| 2-JMS099.30 | 7/15/2003 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 7/15/2003 | M | 2 | | | | | | | |
| 2-JMS099.30 | 7/15/2003 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 7/15/2003 | M | 3 | 27.18 | 7.81 | 7.91 | | | 0 | |
| 2-JMS099.30 | 7/15/2003 | M | 5 | 27.07 | 7.72 | 7.77 | | | 0 | |
| 2-JMS099.30 | 7/15/2003 | B | 7 | 26.95 | 7.67 | 7.71 | | | 0 | |
| 2-JMS099.30 | 8/26/2003 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 8/26/2003 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 8/26/2003 | S | 1 | 29.41 | 8.19 | 8.41 | | | 0 | 0.7 |
| 2-JMS099.30 | 8/26/2003 | M | 1 | | | | | | | |
| 2-JMS099.30 | 8/26/2003 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 8/26/2003 | M | 2 | | | | | | | |
| 2-JMS099.30 | 8/26/2003 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 8/26/2003 | M | 3 | 28.45 | 7.99 | 7.82 | | | 0 | |
| 2-JMS099.30 | 8/26/2003 | B | 3 | | | | | | | |
| 2-JMS099.30 | 8/26/2003 | M | 5 | 28.1 | 7.83 | 7.48 | | | 0 | |
| 2-JMS099.30 | 8/26/2003 | M | 7 | 28 | 7.78 | 7.33 | | | 0 | |
| 2-JMS099.30 | 8/26/2003 | M | 9 | 27.97 | 7.78 | 7.24 | | | 0 | |
| 2-JMS099.30 | 8/26/2003 | M | 11 | 27.95 | 7.77 | 7.15 | | | 0 | |
| 2-JMS099.30 | 8/26/2003 | B | 12 | 27.95 | 7.77 | 7.2 | | | 0 | |
| 2-JMS099.30 | 9/24/2003 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 9/24/2003 | S | 1 | 21.04 | 7.2 | 8.81 | | | 0 | 0.2 |
| 2-JMS099.30 | 9/24/2003 | B | 3 | 21.01 | 7.31 | 8.69 | | | 0 | |
| 2-JMS099.30 | 10/28/2003 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 10/28/2003 | B | 0.5 | | | | | | | |
| 2-JMS099.30 | 10/28/2003 | S | 1 | 15.22 | 7.71 | 9.56 | | | 0 | 1 |
| 2-JMS099.30 | 10/28/2003 | M | 3 | 15.22 | 7.71 | 9.56 | | | 0 | |
| 2-JMS099.30 | 10/28/2003 | M | 5 | 15.23 | 7.7 | 9.47 | | | 0 | |
| 2-JMS099.30 | 10/28/2003 | M | 7 | 15.23 | 7.7 | 9.55 | | | 0 | |
| 2-JMS099.30 | 10/28/2003 | B | 9 | 15.19 | 7.69 | 9.78 | | | 0 | |
| 2-JMS099.30 | 11/18/2003 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 11/18/2003 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 11/18/2003 | S | 1 | 10.4 | 7.57 | 10.34 | | | 0 | 0.5 |
| 2-JMS099.30 | 11/18/2003 | M | 1 | | | | | | | |
| 2-JMS099.30 | 11/18/2003 | B | 1.5 | | | | | | | |
| 2-JMS099.30 | 11/18/2003 | M | 3 | 10.4 | 7.53 | 10.58 | | | 0 | |
| 2-JMS099.30 | 11/18/2003 | M | 5 | 10.39 | 7.51 | 10.55 | | | 0 | |
| 2-JMS099.30 | 11/18/2003 | M | 7 | 10.38 | 7.49 | 10.44 | | | 0 | |
| 2-JMS099.30 | 11/18/2003 | M | 9 | 10.36 | 7.5 | 10.31 | | | 0 | |
| 2-JMS099.30 | 11/18/2003 | M | 11 | 10.4 | 7.5 | 10.31 | | | 0 | |
| 2-JMS099.30 | 11/18/2003 | B | 12 | 10.41 | 7.5 | 10.37 | | | 0 | |
| 2-JMS099.30 | 12/16/2003 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 12/16/2003 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 12/16/2003 | M | 1 | | | | | | | |
| 2-JMS099.30 | 12/16/2003 | S | 1 | 4.23 | 7.26 | 12.72 | | | 0 | 0.4 |
| 2-JMS099.30 | 12/16/2003 | M | 3 | 4.21 | 7.24 | 12.5 | | | 0 | |
| 2-JMS099.30 | 12/16/2003 | M | 5 | 4.21 | 7.22 | 12.58 | | | 0 | |
| 2-JMS099.30 | 12/16/2003 | M | 7 | 4.22 | 7.2 | 12.7 | | | 0 | |
| 2-JMS099.30 | 12/16/2003 | M | 9 | 4.24 | 7.21 | 12.55 | | | 0 | |
| 2-JMS099.30 | 12/16/2003 | B | 10 | 4.26 | 7.21 | 12.66 | | | 0 | |
| 2-JMS099.30 | 2/25/2004 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 2/25/2004 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 2/25/2004 | M | 1 | | | | | | | |
| 2-JMS099.30 | 2/25/2004 | S | 1 | 6.37 | 7.67 | 12.32 | | | 0 | 1.3 |
| 2-JMS099.30 | 2/25/2004 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 2/25/2004 | M | 2 | | | | | | | |
| 2-JMS099.30 | 2/25/2004 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 2/25/2004 | M | 3 | 6.36 | 7.67 | 12.33 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 2/25/2004 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 2/25/2004 | M | 4 | | | | | | | |
| 2-JMS099.30 | 2/25/2004 | M | 4.5 | | | | | | | |
| 2-JMS099.30 | 2/25/2004 | M | 5 | 6.36 | 7.64 | 12.33 | | | 0 | |
| 2-JMS099.30 | 2/25/2004 | M | 7 | 6.37 | 7.65 | 12.35 | | | 0 | |
| 2-JMS099.30 | 2/25/2004 | B | 9 | 6.39 | 7.64 | 12.41 | | | 0 | |
| 2-JMS099.30 | 3/23/2004 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 3/23/2004 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 3/23/2004 | S | 1 | 11.69 | 8.29 | 10.84 | | | 0 | |
| 2-JMS099.30 | 3/23/2004 | M | 1 | | | | | | | |
| 2-JMS099.30 | 3/23/2004 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 3/23/2004 | M | 2 | | | | | | | |
| 2-JMS099.30 | 3/23/2004 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 3/23/2004 | M | 3 | 11.55 | 8.26 | 10.93 | | | 0 | |
| 2-JMS099.30 | 3/23/2004 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 3/23/2004 | M | 4 | | | | | | | |
| 2-JMS099.30 | 3/23/2004 | M | 5 | 11.7 | 8.27 | 10.81 | | | 0 | |
| 2-JMS099.30 | 3/23/2004 | M | 7 | 11.66 | 8.27 | 10.95 | | | 0 | |
| 2-JMS099.30 | 3/23/2004 | B | 8 | 11.64 | 8.25 | 11.17 | | | 0 | |
| 2-JMS099.30 | 4/20/2004 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 4/20/2004 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 4/20/2004 | M | 1 | | | | | | | |
| 2-JMS099.30 | 4/20/2004 | S | 1 | 17.16 | 7.32 | 9.41 | | | 0 | 0.7 |
| 2-JMS099.30 | 4/20/2004 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 4/20/2004 | B | 2 | | | | | | | |
| 2-JMS099.30 | 4/20/2004 | M | 3 | 16.91 | 7.32 | 9.39 | | | 0 | |
| 2-JMS099.30 | 4/20/2004 | M | 5 | 16.85 | 7.32 | 9.49 | | | 0 | |
| 2-JMS099.30 | 4/20/2004 | B | 7 | 16.83 | 7.33 | 9.52 | | | 0 | |
| 2-JMS099.30 | 5/18/2004 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 5/18/2004 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 5/18/2004 | S | 1 | | 7.43 | | | | | |
| 2-JMS099.30 | 5/18/2004 | M | 1 | | | | | | | |
| 2-JMS099.30 | 5/18/2004 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 5/18/2004 | M | 2 | | | | | | | |
| 2-JMS099.30 | 5/18/2004 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 5/18/2004 | M | 3 | | 7.45 | | | | | |
| 2-JMS099.30 | 5/18/2004 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 5/18/2004 | M | 5 | | 7.39 | | | | | |
| 2-JMS099.30 | 5/18/2004 | M | 7 | | 7.38 | | | | | |
| 2-JMS099.30 | 5/18/2004 | M | 9 | | 7.32 | | | | | |
| 2-JMS099.30 | 5/18/2004 | B | 11 | | 7.3 | | | | | |
| 2-JMS099.30 | 6/15/2004 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 6/15/2004 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 6/15/2004 | M | 1 | | | | | | | |
| 2-JMS099.30 | 6/15/2004 | S | 1 | 26.02 | 7.37 | 7.75 | | | 0 | 0.8 |
| 2-JMS099.30 | 6/15/2004 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 6/15/2004 | M | 2 | | | | | | | |
| 2-JMS099.30 | 6/15/2004 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 6/15/2004 | M | 3 | 24.96 | 7.37 | 7.59 | | | 0 | |
| 2-JMS099.30 | 6/15/2004 | M | 5 | 24.9 | 7.33 | 7.51 | | | 0 | |
| 2-JMS099.30 | 6/15/2004 | M | 7 | 24.79 | 7.33 | 7.47 | | | 0 | |
| 2-JMS099.30 | 6/15/2004 | M | 9 | 24.69 | 7.34 | 7.4 | | | 0 | |
| 2-JMS099.30 | 6/15/2004 | B | 11 | 24.65 | 7.34 | 7.32 | | | 0 | |
| 2-JMS099.30 | 7/20/2004 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 7/20/2004 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 7/20/2004 | M | 1 | | | | | | | |
| 2-JMS099.30 | 7/20/2004 | S | 1 | 28.35 | 7.78 | 7.2 | | | 0 | 0.9 |
| 2-JMS099.30 | 7/20/2004 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 7/20/2004 | M | 2 | | | | | | | |
| 2-JMS099.30 | 7/20/2004 | M | 3 | 27.7 | 7.67 | 6.8 | | | 0 | |
| 2-JMS099.30 | 7/20/2004 | M | 5 | 27.63 | 7.67 | 6.49 | | | 0 | |
| 2-JMS099.30 | 7/20/2004 | M | 7 | 27.6 | 7.68 | 6.78 | | | 0 | |
| 2-JMS099.30 | 7/20/2004 | M | 9 | 27.57 | 7.66 | 6.64 | | | 0 | |
| 2-JMS099.30 | 7/20/2004 | B | 11 | 27.58 | 7.65 | 6.45 | | | 0 | |
| 2-JMS099.30 | 8/17/2004 | S | 1 | 22.91 | 7.14 | 6.97 | | | 0 | 0.3 |
| 2-JMS099.30 | 8/17/2004 | M | 3 | 22.92 | 7.12 | 6.93 | | | 0 | |
| 2-JMS099.30 | 8/17/2004 | M | 5 | 22.89 | 7.12 | 7.23 | | | 0 | |
| 2-JMS099.30 | 8/17/2004 | B | 6 | 22.9 | 7.13 | 7.2 | | | 0 | |
| 2-JMS099.30 | 9/21/2004 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 9/21/2004 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 9/21/2004 | M | 1 | | | | | | | |
| 2-JMS099.30 | 9/21/2004 | S | 1 | 20.53 | 7.56 | 8.55 | | | 0 | 0.4 |
| 2-JMS099.30 | 9/21/2004 | B | 1.5 | | | | | | | |
| 2-JMS099.30 | 9/21/2004 | M | 3 | 20.52 | 7.55 | 8.54 | | | 0 | |
| 2-JMS099.30 | 9/21/2004 | M | 5 | 20.52 | 7.55 | 8.51 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 9/21/2004 | M | 7 | 20.48 | 7.56 | 8.63 | | | 0 | |
| 2-JMS099.30 | 9/21/2004 | M | 9 | 20.47 | 7.55 | 8.57 | | | 0 | |
| 2-JMS099.30 | 9/21/2004 | M | 11 | 20.46 | 7.64 | 8.65 | | | 0 | |
| 2-JMS099.30 | 9/21/2004 | B | 12 | 20.47 | 7.63 | 8.64 | | | 0 | |
| 2-JMS099.30 | 10/19/2004 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 10/19/2004 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 10/19/2004 | M | 1 | | | | | | | |
| 2-JMS099.30 | 10/19/2004 | S | 1 | 15.56 | 7.75 | 9.07 | | | 0 | 0.9 |
| 2-JMS099.30 | 10/19/2004 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 10/19/2004 | M | 2 | | | | | | | |
| 2-JMS099.30 | 10/19/2004 | M | 3 | 15.56 | 7.75 | 9.12 | | | 0 | |
| 2-JMS099.30 | 10/19/2004 | M | 5 | 15.54 | 7.71 | 9.26 | | | 0 | |
| 2-JMS099.30 | 10/19/2004 | M | 7 | 15.48 | 7.68 | 9.35 | | | 0 | |
| 2-JMS099.30 | 10/19/2004 | B | 9 | 15.42 | 7.69 | 9.56 | | | 0 | |
| 2-JMS099.30 | 11/16/2004 | S | 1 | 9.19 | 7.47 | 11.32 | | | 0 | 0.4 |
| 2-JMS099.30 | 11/16/2004 | M | 3 | 9.17 | 7.49 | 11.32 | | | 0 | |
| 2-JMS099.30 | 11/16/2004 | M | 5 | 9.19 | 7.49 | 11.33 | | | 0 | |
| 2-JMS099.30 | 11/16/2004 | M | 7 | 9.16 | 7.48 | 11.35 | | | 0 | |
| 2-JMS099.30 | 11/16/2004 | M | 9 | 9.12 | 7.39 | 11.43 | | | 0 | |
| 2-JMS099.30 | 11/16/2004 | M | 11 | 9.13 | 7.38 | 11.42 | | | 0 | |
| 2-JMS099.30 | 11/16/2004 | B | 12 | 9.14 | 7.44 | 11.49 | | | 0 | |
| 2-JMS099.30 | 12/14/2004 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 12/14/2004 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 12/14/2004 | S | 1 | 8.29 | 7.74 | 11.33 | | | 0 | 0.6 |
| 2-JMS099.30 | 12/14/2004 | B | 1 | | | | | | | |
| 2-JMS099.30 | 12/14/2004 | M | 3 | 8.29 | 7.72 | 11.36 | | | 0 | |
| 2-JMS099.30 | 12/14/2004 | M | 5 | 8.28 | 7.73 | 11.27 | | | 0 | |
| 2-JMS099.30 | 12/14/2004 | M | 7 | 8.28 | 7.71 | 11.3 | | | 0 | |
| 2-JMS099.30 | 12/14/2004 | B | 8 | 8.29 | 7.73 | 11.51 | | | 0 | |
| 2-JMS099.30 | 1/26/2005 | S | 1 | 1.26 | 7.66 | 13.83 | | | 0 | 0.9 |
| 2-JMS099.30 | 1/26/2005 | M | 3 | 1.27 | 7.66 | 13.81 | | | 0 | |
| 2-JMS099.30 | 1/26/2005 | M | 5 | 1.27 | 7.65 | 13.75 | | | 0 | |
| 2-JMS099.30 | 1/26/2005 | M | 7 | 1.31 | 7.63 | 13.9 | | | 0 | |
| 2-JMS099.30 | 1/26/2005 | M | 9 | 1.31 | 7.63 | 13.93 | | | 0 | |
| 2-JMS099.30 | 1/26/2005 | M | 11 | 1.35 | 7.66 | 13.96 | | | 0 | |
| 2-JMS099.30 | 1/26/2005 | B | 12 | 1.33 | 7.7 | 14.13 | | | 0 | |
| 2-JMS099.30 | 2/15/2005 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 2/15/2005 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 2/15/2005 | M | 1 | | | | | | | |
| 2-JMS099.30 | 2/15/2005 | S | 1 | 7.23 | 7.81 | 11.88 | | | 0 | 1.8 |
| 2-JMS099.30 | 2/15/2005 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 2/15/2005 | M | 2 | | | | | | | |
| 2-JMS099.30 | 2/15/2005 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 2/15/2005 | M | 3 | 7.2 | 7.75 | 11.89 | | | 0 | |
| 2-JMS099.30 | 2/15/2005 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 2/15/2005 | M | 4 | | | | | | | |
| 2-JMS099.30 | 2/15/2005 | M | 5 | 7.1 | 7.78 | 11.85 | | | 0 | |
| 2-JMS099.30 | 2/15/2005 | M | 7 | 7.17 | 7.8 | 11.87 | | | 0 | |
| 2-JMS099.30 | 2/15/2005 | M | 9 | 7.17 | 7.76 | 11.91 | | | 0 | |
| 2-JMS099.30 | 2/15/2005 | B | 11 | 7.13 | 7.8 | 12.03 | | | 0 | |
| 2-JMS099.30 | 3/22/2005 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 3/22/2005 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 3/22/2005 | S | 1 | 11.92 | 8.57 | 11.29 | | | 0 | 1.5 |
| 2-JMS099.30 | 3/22/2005 | M | 1 | | | | | | | |
| 2-JMS099.30 | 3/22/2005 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 3/22/2005 | M | 2 | | | | | | | |
| 2-JMS099.30 | 3/22/2005 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 3/22/2005 | M | 3 | 11.5 | 8.5 | 11.26 | | | 0 | |
| 2-JMS099.30 | 3/22/2005 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 3/22/2005 | M | 4 | | | | | | | |
| 2-JMS099.30 | 3/22/2005 | B | 4.5 | | | | | | | |
| 2-JMS099.30 | 3/22/2005 | M | 5 | 11.22 | 8.55 | 11.47 | | | 0 | |
| 2-JMS099.30 | 3/22/2005 | M | 7 | 11.16 | 8.5 | 11.41 | | | 0 | |
| 2-JMS099.30 | 3/22/2005 | M | 9 | 11.15 | 8.51 | 11.52 | | | 0 | |
| 2-JMS099.30 | 3/22/2005 | B | 11 | 11.12 | 8.54 | 11.78 | | | 0 | |
| 2-JMS099.30 | 4/19/2005 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 4/19/2005 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 4/19/2005 | M | 1 | | | | | | | |
| 2-JMS099.30 | 4/19/2005 | S | 1 | 17.8 | 8.09 | 9.41 | | | 0 | 0.8 |
| 2-JMS099.30 | 4/19/2005 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 4/19/2005 | M | 2 | | | | | | | |
| 2-JMS099.30 | 4/19/2005 | B | 2.5 | | | | | | | |
| 2-JMS099.30 | 4/19/2005 | M | 3 | 17.4 | 8 | 9.6 | | | 0 | |
| 2-JMS099.30 | 4/19/2005 | M | 5 | 17.2 | 7.94 | 9.6 | | | 0 | |
| 2-JMS099.30 | 4/19/2005 | M | 7 | 17 | 7.92 | 9.6 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 4/19/2005 | M | 9 | 16.8 | 7.85 | 9.79 | | | 0 | |
| 2-JMS099.30 | 4/19/2005 | M | 11 | 16.1 | 7.82 | 9.87 | | | 0 | |
| 2-JMS099.30 | 4/19/2005 | B | 12 | 16.1 | 7.84 | 9.95 | | | 0 | |
| 2-JMS099.30 | 5/24/2005 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 5/24/2005 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 5/24/2005 | M | 1 | | | | | | | |
| 2-JMS099.30 | 5/24/2005 | S | 1 | 21.01 | 7.22 | 7.51 | | | | 0.7 |
| 2-JMS099.30 | 5/24/2005 | M | 3 | 21.06 | 7.47 | 7.71 | | | 0 | |
| 2-JMS099.30 | 5/24/2005 | M | 5 | 21.02 | 7.45 | 7.69 | | | 0 | |
| 2-JMS099.30 | 5/24/2005 | M | 7 | 21 | 7.43 | 7.76 | | | | |
| 2-JMS099.30 | 5/24/2005 | M | 9 | 20.97 | 7.41 | 7.75 | | | 0 | |
| 2-JMS099.30 | 5/24/2005 | B | 11 | 20.97 | 7.51 | 7.75 | | | 0 | |
| 2-JMS099.30 | 6/21/2005 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 6/21/2005 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 6/21/2005 | M | 1 | | | | | | | |
| 2-JMS099.30 | 6/21/2005 | S | 1 | 27.6 | 7.68 | 6.77 | | | 0 | 0.8 |
| 2-JMS099.30 | 6/21/2005 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 6/21/2005 | M | 2 | | | | | | | |
| 2-JMS099.30 | 6/21/2005 | M | 3 | 27.4 | 7.62 | 6.48 | | | 0 | |
| 2-JMS099.30 | 6/21/2005 | M | 5 | 27.2 | 7.58 | 6.33 | | | 0 | |
| 2-JMS099.30 | 6/21/2005 | M | 7 | 27.2 | 7.57 | 6.31 | | | 0 | |
| 2-JMS099.30 | 6/21/2005 | M | 9 | 27.2 | 7.54 | 6.29 | | | 0 | |
| 2-JMS099.30 | 6/21/2005 | B | 10 | 27.1 | 7.52 | 6.32 | | | 0 | |
| 2-JMS099.30 | 7/19/2005 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 7/19/2005 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 7/19/2005 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 7/19/2005 | S | 1 | 31.19 | 7.68 | 6.97 | | | 0 | 0.8 |
| 2-JMS099.30 | 7/19/2005 | M | 1 | | | | | | | |
| 2-JMS099.30 | 7/19/2005 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 7/19/2005 | M | 2 | | | | | | | |
| 2-JMS099.30 | 7/19/2005 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 7/19/2005 | M | 3 | 30.74 | 7.62 | 6.69 | | | 0 | |
| 2-JMS099.30 | 7/19/2005 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 7/19/2005 | B | 4 | | | | | | | |
| 2-JMS099.30 | 7/19/2005 | M | 5 | 30.66 | 7.59 | 6.58 | | | 0 | |
| 2-JMS099.30 | 7/19/2005 | M | 7 | 30.53 | 7.54 | 6.44 | | | 0 | |
| 2-JMS099.30 | 7/19/2005 | M | 9 | 30.49 | 7.51 | 6.48 | | | 0 | |
| 2-JMS099.30 | 7/19/2005 | M | 11 | 30.49 | 7.44 | 6.3 | | | 0 | |
| 2-JMS099.30 | 7/19/2005 | B | 12 | 30.46 | 7.44 | 6.35 | | | 0 | |
| 2-JMS099.30 | 8/23/2005 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 8/23/2005 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 8/23/2005 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 8/23/2005 | M | 1 | | | | | | | |
| 2-JMS099.30 | 8/23/2005 | S | 1 | 29.9 | 7.36 | 6.22 | | | 0 | 1 |
| 2-JMS099.30 | 8/23/2005 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 8/23/2005 | M | 2 | | | | | | | |
| 2-JMS099.30 | 8/23/2005 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 8/23/2005 | M | 3 | 29.8 | 7.4 | 6.01 | | | 0 | |
| 2-JMS099.30 | 8/23/2005 | M | 5 | 29.8 | 7.4 | 6.06 | | | 0 | |
| 2-JMS099.30 | 8/23/2005 | M | 7 | 29.9 | 7.48 | 6.13 | | | 0 | |
| 2-JMS099.30 | 8/23/2005 | M | 9 | 29.8 | 7.43 | 6.09 | | | 0 | |
| 2-JMS099.30 | 8/23/2005 | B | 10 | 29.8 | 7.43 | 6.06 | | | 0 | |
| 2-JMS099.30 | 9/20/2005 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 9/20/2005 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 9/20/2005 | M | 1 | | | | | | | |
| 2-JMS099.30 | 9/20/2005 | S | 1 | 27.9 | 7.8 | 7.7 | | | 0 | 0.7 |
| 2-JMS099.30 | 9/20/2005 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 9/20/2005 | M | 3 | 27.5 | 7.63 | 7.06 | | | 0 | |
| 2-JMS099.30 | 9/20/2005 | M | 5 | 27.5 | 7.63 | 7.14 | | | 0 | |
| 2-JMS099.30 | 9/20/2005 | M | 7 | 27.6 | 7.77 | 7.34 | | | 0 | |
| 2-JMS099.30 | 9/20/2005 | M | 9 | 27.6 | 7.71 | 7.23 | | | 0 | |
| 2-JMS099.30 | 9/20/2005 | M | 11 | 27.6 | 7.7 | 7.25 | | | 0 | |
| 2-JMS099.30 | 9/20/2005 | B | 12 | 27.6 | 7.72 | 7.24 | | | 0 | |
| 2-JMS099.30 | 10/18/2005 | S | 0.3 | | | | | | | |
| 2-JMS099.30 | 10/18/2005 | S | 1 | 19.1 | 7.31 | 8.43 | | | 0 | 1.2 |
| 2-JMS099.30 | 10/18/2005 | M | 3 | 19 | 7.38 | 8.34 | | | 0 | |
| 2-JMS099.30 | 10/18/2005 | M | 5 | 18.9 | 7.41 | 8.3 | | | 0 | |
| 2-JMS099.30 | 10/18/2005 | M | 7 | 18.9 | 7.41 | 8.19 | | | 0 | |
| 2-JMS099.30 | 10/18/2005 | M | 9 | 18.9 | 7.42 | 7.75 | | | 0 | |
| 2-JMS099.30 | 10/18/2005 | M | 11 | 18.9 | 7.38 | 6.08 | | | 0 | |
| 2-JMS099.30 | 10/18/2005 | B | 12 | 19 | 7.36 | 4.54 | | | 0 | |
| 2-JMS099.30 | 11/15/2005 | S | 0.3 | | 7.67 | 9.22 | | | | |
| 2-JMS099.30 | 11/15/2005 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 11/15/2005 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 11/15/2005 | S | 1 | 15.4 | 7.67 | 9.22 | | | 0 | 1 |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 11/15/2005 | M | 1 | | | | | | | |
| 2-JMS099.30 | 11/15/2005 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 11/15/2005 | M | 2 | | | | | | | |
| 2-JMS099.30 | 11/15/2005 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 11/15/2005 | B | 3 | | | | | | | |
| 2-JMS099.30 | 11/15/2005 | M | 3 | 14.9 | 7.65 | 9.17 | | | 0 | |
| 2-JMS099.30 | 11/15/2005 | M | 5 | 14.9 | 7.65 | 9.16 | | | 0 | |
| 2-JMS099.30 | 11/15/2005 | M | 7 | 14.7 | 7.61 | 9.13 | | | 0 | |
| 2-JMS099.30 | 11/15/2005 | M | 9 | 14.7 | 7.56 | 9.03 | | | 0 | |
| 2-JMS099.30 | 11/15/2005 | M | 11 | 14.7 | 7.56 | 8.97 | | | 0 | |
| 2-JMS099.30 | 11/15/2005 | B | 12 | 14.7 | 7.59 | 9.01 | | | 0 | |
| 2-JMS099.30 | 12/13/2005 | S | 1 | | | | | | | |
| 2-JMS099.30 | 12/13/2005 | S | 0.3 | 4.05 | 7.21 | 12.8 | | | | |
| 2-JMS099.30 | 12/21/2005 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 12/21/2005 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 12/21/2005 | S | 1 | 3.91 | 7.49 | 13.06 | | | 0 | 0.6 |
| 2-JMS099.30 | 12/21/2005 | M | 1 | | | | | | | |
| 2-JMS099.30 | 12/21/2005 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 12/21/2005 | B | 2 | | | | | | | |
| 2-JMS099.30 | 12/21/2005 | M | 3 | 3.91 | 7.51 | 13.02 | | | 0 | |
| 2-JMS099.30 | 12/21/2005 | M | 5 | 3.91 | 7.51 | 12.96 | | | 0 | |
| 2-JMS099.30 | 12/21/2005 | M | 7 | 3.91 | 7.48 | 12.95 | | | 0 | |
| 2-JMS099.30 | 12/21/2005 | M | 9 | 3.92 | 7.45 | 12.92 | | | 0 | |
| 2-JMS099.30 | 12/21/2005 | B | 11 | 3.94 | 7.45 | 12.9 | | | 0 | |
| 2-JMS099.30 | 1/17/2006 | S | 0 | | | | | | | |
| 2-JMS099.30 | 1/17/2006 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 1/17/2006 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 1/17/2006 | M | 1 | | | | | | | |
| 2-JMS099.30 | 1/17/2006 | S | 1 | 5.9 | 7.47 | 12.52 | | | 0 | 0.4 |
| 2-JMS099.30 | 1/17/2006 | M | 3 | 5.9 | 7.46 | 12.57 | | | 0 | |
| 2-JMS099.30 | 1/17/2006 | M | 5 | 5.9 | 7.44 | 12.61 | | | 0 | |
| 2-JMS099.30 | 1/17/2006 | M | 7 | 5.9 | 7.33 | 12.64 | | | 0 | |
| 2-JMS099.30 | 1/17/2006 | M | 9 | 5.9 | 7.26 | 12.63 | | | 0 | |
| 2-JMS099.30 | 1/17/2006 | B | 10 | 5.9 | 7.26 | 12.67 | | | 0 | |
| 2-JMS099.30 | 1/17/2006 | S | 0 | | | | | | | |
| 2-JMS099.30 | 2/21/2006 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 2/21/2006 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 2/21/2006 | S | 1 | 6.4 | 7.5 | 12.9 | | | 0 | 2 |
| 2-JMS099.30 | 2/21/2006 | M | 1 | | | | | | | |
| 2-JMS099.30 | 2/21/2006 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 2/21/2006 | M | 2 | | | | | | | |
| 2-JMS099.30 | 2/21/2006 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 2/21/2006 | M | 3 | 6.3 | 7.61 | 12.91 | | | 0 | |
| 2-JMS099.30 | 2/21/2006 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 2/21/2006 | B | 4 | 6.3 | 7.5 | 13 | | | 0 | |
| 2-JMS099.30 | 2/21/2006 | M | 4 | | | | | | | |
| 2-JMS099.30 | 2/21/2006 | M | 4.5 | | | | | | | |
| 2-JMS099.30 | 2/21/2006 | M | 5 | | | | | | | |
| 2-JMS099.30 | 2/21/2006 | B | 5.5 | | | | | | | |
| 2-JMS099.30 | 3/20/2006 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 3/20/2006 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 3/20/2006 | S | 1 | 12.9 | 7.9 | 10.1 | | | | 1.7 |
| 2-JMS099.30 | 3/20/2006 | M | 1 | | | | | | | |
| 2-JMS099.30 | 3/20/2006 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 3/20/2006 | M | 2 | | | | | | | |
| 2-JMS099.30 | 3/20/2006 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 3/20/2006 | M | 3 | 12.9 | 7.9 | 10.1 | | | | |
| 2-JMS099.30 | 3/20/2006 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 3/20/2006 | M | 5 | 12.8 | 7.9 | 10.1 | | | | |
| 2-JMS099.30 | 3/20/2006 | M | 7 | 12.8 | 7.9 | 10.1 | | | | |
| 2-JMS099.30 | 3/20/2006 | M | 9 | 12.8 | 7.9 | 10.2 | | | | |
| 2-JMS099.30 | 3/20/2006 | B | 11 | 12.8 | 7.8 | 10.2 | | | | |
| 2-JMS099.30 | 4/26/2006 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 4/26/2006 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 4/26/2006 | S | 1 | 21.4 | 7.5 | 7.6 | | | 0 | 1.4 |
| 2-JMS099.30 | 4/26/2006 | M | 1 | | | | | | | |
| 2-JMS099.30 | 4/26/2006 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 4/26/2006 | M | 2 | | | | | | | |
| 2-JMS099.30 | 4/26/2006 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 4/26/2006 | B | 3 | | | | | | | |
| 2-JMS099.30 | 4/26/2006 | M | 3 | 21.3 | 7.5 | 7.6 | | | 0 | |
| 2-JMS099.30 | 4/26/2006 | M | 5 | 21.3 | 7.5 | 7.6 | | | 0 | |
| 2-JMS099.30 | 4/26/2006 | M | 7 | 21.2 | 7.5 | 7.6 | | | 0 | |
| 2-JMS099.30 | 4/26/2006 | M | 9 | 21.2 | 7.5 | 7.7 | | | 0 | |
| 2-JMS099.30 | 4/26/2006 | B | 11 | 21.2 | 7.5 | 7.6 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 5/15/2006 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 5/15/2006 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 5/15/2006 | S | 1 | 21 | 7.8 | 7.2 | | | 0 | 1 |
| 2-JMS099.30 | 5/15/2006 | M | 1 | | | | | | | |
| 2-JMS099.30 | 5/15/2006 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 5/15/2006 | M | 2 | | | | | | | |
| 2-JMS099.30 | 5/15/2006 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 5/15/2006 | M | 3 | 21.1 | 7.7 | 7.2 | | | 0 | |
| 2-JMS099.30 | 5/15/2006 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 5/15/2006 | M | 4 | | | | | | | |
| 2-JMS099.30 | 5/15/2006 | B | 4.5 | | | | | | | |
| 2-JMS099.30 | 5/15/2006 | M | 5 | 20.9 | 7.7 | 7.2 | | | 0 | |
| 2-JMS099.30 | 5/15/2006 | B | 6 | 20.9 | 7.7 | 7.1 | | | 0 | |
| 2-JMS099.30 | 6/21/2006 | S | 0.3 | 27.8 | 7.6 | 7.2 | | | 0 | |
| 2-JMS099.30 | 6/29/2006 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 6/29/2006 | S | 1 | | | | | | | |
| 2-JMS099.30 | 7/24/2006 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 7/24/2006 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 7/24/2006 | S | 1 | 30.5 | 7.6 | 6.2 | | | 0 | |
| 2-JMS099.30 | 7/24/2006 | M | 1 | | | | | | | |
| 2-JMS099.30 | 7/24/2006 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 7/24/2006 | M | 2 | | | | | | | |
| 2-JMS099.30 | 7/24/2006 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 7/24/2006 | M | 3 | 30 | 7.5 | 5.8 | | | 0 | |
| 2-JMS099.30 | 7/24/2006 | B | 3.5 | | | | | | | |
| 2-JMS099.30 | 7/24/2006 | M | 5 | 29.5 | 7.5 | 5.7 | | | 0 | |
| 2-JMS099.30 | 7/24/2006 | M | 7 | 29.3 | 7.5 | 5.6 | | | 0 | |
| 2-JMS099.30 | 7/24/2006 | M | 9 | 29.3 | 7.5 | 5.7 | | | 0 | |
| 2-JMS099.30 | 7/24/2006 | B | 10 | 29.3 | 7.5 | 5.7 | | | 0 | |
| 2-JMS099.30 | 8/22/2006 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 8/22/2006 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 8/22/2006 | S | 1 | 31.3 | 7.7 | 7.3 | | | 0 | 0.6 |
| 2-JMS099.30 | 8/22/2006 | B | 1 | | | | | | | |
| 2-JMS099.30 | 8/22/2006 | M | 3 | 30.5 | 7.6 | 7.1 | | | 0 | |
| 2-JMS099.30 | 8/22/2006 | M | 5 | 29.9 | 7.6 | 6.9 | | | 0 | |
| 2-JMS099.30 | 8/22/2006 | M | 7 | 30 | 7.6 | 7.1 | | | 0 | |
| 2-JMS099.30 | 8/22/2006 | B | 9 | 29.6 | 7.4 | 6.3 | | | 0 | |
| 2-JMS099.30 | 9/27/2006 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 9/27/2006 | S | 1 | 23.3 | 7.6 | 8.2 | | | 0 | |
| 2-JMS099.30 | 10/30/2006 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 10/30/2006 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 10/30/2006 | M | 1 | | | | | | | |
| 2-JMS099.30 | 10/30/2006 | S | 1 | 11.8 | 7.4 | 10 | | | 0 | 0.5 |
| 2-JMS099.30 | 10/30/2006 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 10/30/2006 | M | 3 | 11.8 | 7.4 | 10 | | | 0 | |
| 2-JMS099.30 | 10/30/2006 | M | 5 | 11.8 | 7.4 | 10.1 | | | 0 | |
| 2-JMS099.30 | 10/30/2006 | M | 7 | 11.8 | 7.4 | 10.1 | | | 0 | |
| 2-JMS099.30 | 10/30/2006 | M | 9 | 11.8 | 7.4 | 10.2 | | | 0 | |
| 2-JMS099.30 | 10/30/2006 | B | 10 | 11.8 | 7.4 | 10.4 | | | 0 | |
| 2-JMS099.30 | 11/15/2006 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 11/15/2006 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 11/15/2006 | M | 1 | | | | | | | |
| 2-JMS099.30 | 11/15/2006 | S | 1 | 12.7 | 7.3 | 9.7 | | | 0 | 0.5 |
| 2-JMS099.30 | 11/15/2006 | M | 3 | 12.7 | 7.3 | 9.6 | | | 0 | |
| 2-JMS099.30 | 11/15/2006 | M | 5 | 12.6 | 7.3 | 9.7 | | | 0 | |
| 2-JMS099.30 | 11/15/2006 | M | 7 | 12.7 | 7.3 | 9.7 | | | 0 | |
| 2-JMS099.30 | 11/15/2006 | M | 9 | 12.7 | 7.3 | 9.8 | | | 0 | |
| 2-JMS099.30 | 11/15/2006 | B | 10 | 12.7 | 7.4 | 9.9 | | | 0 | |
| 2-JMS099.30 | 12/18/2006 | S | 1 | 7.5 | 7.2 | 12.2 | | | 0 | |
| 2-JMS099.30 | 1/24/2007 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 1/24/2007 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 1/24/2007 | S | 1 | 5.2 | 7.8 | 12.2 | | | 0 | 1.3 |
| 2-JMS099.30 | 1/24/2007 | M | 1 | | | | | | | |
| 2-JMS099.30 | 1/24/2007 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 1/24/2007 | M | 2 | | | | | | | |
| 2-JMS099.30 | 1/24/2007 | M | 2.5 | | | | | | | |
| 2-JMS099.30 | 1/24/2007 | M | 3 | 5.2 | 7.8 | 12.2 | | | 0 | |
| 2-JMS099.30 | 1/24/2007 | M | 3.5 | | | | | | | |
| 2-JMS099.30 | 1/24/2007 | M | 4 | | | | | | | |
| 2-JMS099.30 | 1/24/2007 | M | 4.5 | | | | | | | |
| 2-JMS099.30 | 1/24/2007 | M | 5 | 5.2 | 7.8 | 12.3 | | | 0 | |
| 2-JMS099.30 | 1/24/2007 | M | 7 | 5.2 | 7.8 | 12.2 | | | 0 | |
| 2-JMS099.30 | 1/24/2007 | M | 9 | 5.2 | 7.8 | 12.2 | | | 0 | |
| 2-JMS099.30 | 1/24/2007 | B | 10 | 5.2 | 7.8 | 12.3 | | | 0 | |
| 2-JMS099.30 | 2/20/2007 | S | 0.1 | | | | | | | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 2/20/2007 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 2/20/2007 | M | 1 | | | | | | | |
| 2-JMS099.30 | 2/20/2007 | S | 1 | 3.3 | 7.5 | 13.1 | | | 0 | 0.4 |
| 2-JMS099.30 | 2/20/2007 | M | 1.5 | | | | | | | |
| 2-JMS099.30 | 2/20/2007 | M | 2 | | | | | | | |
| 2-JMS099.30 | 2/20/2007 | M | 3 | 3.2 | 7.5 | 13.1 | | | 0 | |
| 2-JMS099.30 | 2/20/2007 | M | 5 | 3.1 | 7.5 | 13.2 | | | 0 | |
| 2-JMS099.30 | 2/20/2007 | M | 7 | 3.1 | 7.5 | 13.3 | | | 0 | |
| 2-JMS099.30 | 2/20/2007 | B | 8 | 3.2 | 7.4 | 13.3 | | | 0 | |
| 2-JMS099.30 | 3/19/2007 | S | 0.1 | | | | | | | |
| 2-JMS099.30 | 3/19/2007 | M | 0.5 | | | | | | | |
| 2-JMS099.30 | 3/19/2007 | S | 1 | 8.3 | 7.2 | 11.6 | | | 0 | 0.2 |
| 2-JMS099.30 | 3/19/2007 | M | 1 | | | | | | | |
| 2-JMS099.30 | 3/19/2007 | M | 3 | 8.3 | 7.2 | 11.6 | | | 0 | |
| 2-JMS099.30 | 3/19/2007 | M | 5 | 8.3 | 7.2 | 11.5 | | | 0 | |
| 2-JMS099.30 | 3/19/2007 | M | 7 | 8.3 | 7.1 | 11.6 | | | 0 | |
| 2-JMS099.30 | 3/19/2007 | M | 9 | 8.3 | 7.1 | 11.6 | | | 0 | |
| 2-JMS099.30 | 3/19/2007 | B | 11 | 8.3 | 7.1 | 11.6 | | | 0 | |
| 2-JMS099.30 | 4/30/2007 | S | 1 | 21.3 | 8.1 | 9 | | | 0 | 1.2 |
| 2-JMS099.30 | 4/30/2007 | M | 3 | 20.1 | 8 | 8.9 | | | 0 | |
| 2-JMS099.30 | 4/30/2007 | M | 5 | 20 | 7.9 | 8.8 | | | 0 | |
| 2-JMS099.30 | 4/30/2007 | M | 7 | 19.9 | 7.9 | 8.8 | | | 0 | |
| 2-JMS099.30 | 4/30/2007 | M | 9 | 19.9 | 7.8 | 8.8 | | | 0 | |
| 2-JMS099.30 | 4/30/2007 | B | 10 | 19.9 | 7.8 | 8.9 | | | 0 | |
| 2-JMS099.30 | 5/30/2007 | S | 1 | 27.7 | 7.7 | 7 | | | 0 | 1.2 |
| 2-JMS099.30 | 5/30/2007 | M | 2 | 27.5 | 7.6 | 6.7 | | | 0 | |
| 2-JMS099.30 | 5/30/2007 | M | 3 | 27.2 | 7.5 | 6.4 | | | 0 | |
| 2-JMS099.30 | 5/30/2007 | M | 4 | 27.1 | 7.5 | 6.4 | | | 0 | |
| 2-JMS099.30 | 5/30/2007 | M | 5 | 27 | 7.5 | 6.4 | | | 0 | |
| 2-JMS099.30 | 5/30/2007 | M | 6 | 27 | 7.5 | 6.1 | | | 0 | |
| 2-JMS099.30 | 5/30/2007 | M | 7 | 26.9 | 7.5 | 6.1 | | | 0 | |
| 2-JMS099.30 | 5/30/2007 | M | 8 | 26.9 | 7.5 | 6.1 | | | 0 | |
| 2-JMS099.30 | 5/30/2007 | M | 9 | 26.9 | 7.5 | 6 | | | 0 | |
| 2-JMS099.30 | 5/30/2007 | B | 10 | 26.9 | 7.5 | 6.1 | | | 0 | |
| 2-JMS099.30 | 6/18/2007 | S | 1 | 26.4 | 7.7 | 7.6 | | | 0 | 1 |
| 2-JMS099.30 | 6/18/2007 | M | 2 | 25.9 | 7.6 | 7.2 | | | 0 | |
| 2-JMS099.30 | 6/18/2007 | M | 3 | 25.6 | 7.5 | 7.1 | | | 0 | |
| 2-JMS099.30 | 6/18/2007 | M | 4 | 25.5 | 7.5 | 7 | | | 0 | |
| 2-JMS099.30 | 6/18/2007 | M | 5 | 25.4 | 7.5 | 7 | | | 0 | |
| 2-JMS099.30 | 6/18/2007 | M | 6 | 25.3 | 7.5 | 7 | | | 0 | |
| 2-JMS099.30 | 6/18/2007 | M | 7 | 25.3 | 7.5 | 6.9 | | | 0 | |
| 2-JMS099.30 | 6/18/2007 | M | 8 | 25.3 | 7.4 | 6.9 | | | 0 | |
| 2-JMS099.30 | 6/18/2007 | M | 9 | 25.2 | 7.4 | 6.9 | | | 0 | |
| 2-JMS099.30 | 6/18/2007 | B | 10 | 25.2 | 7.4 | 6.9 | | | 0 | |
| 2-JMS099.30 | 7/23/2007 | S | 1 | 28.7 | 7.6 | 6.5 | | 7 | 0 | 1.1 |
| 2-JMS099.30 | 7/23/2007 | M | 2 | 28.6 | 7.6 | 6.3 | | 6.7 | 0 | |
| 2-JMS099.30 | 7/23/2007 | M | 3 | 28.6 | 7.6 | 6.2 | | 6.5 | 0 | |
| 2-JMS099.30 | 7/23/2007 | M | 4 | 28.5 | 7.5 | 6.1 | | 6.4 | 0 | |
| 2-JMS099.30 | 7/23/2007 | M | 5 | 28.5 | 7.5 | 6 | | 6.3 | 0 | |
| 2-JMS099.30 | 7/23/2007 | M | 6 | 28.5 | 7.5 | 6 | | 6.3 | 0 | |
| 2-JMS099.30 | 7/23/2007 | M | 7 | 28.4 | 7.5 | 5.9 | | 6.2 | 0 | |
| 2-JMS099.30 | 7/23/2007 | M | 8 | 28.4 | 7.5 | 5.7 | | 6.1 | 0 | |
| 2-JMS099.30 | 7/23/2007 | M | 9 | 28.4 | 7.5 | 5.7 | | 6.1 | 0 | |
| 2-JMS099.30 | 7/23/2007 | M | 10 | 28.4 | 7.5 | 5.8 | | 6 | 0 | |
| 2-JMS099.30 | 7/23/2007 | B | 11 | 28.3 | 7.4 | 5.7 | | 5.9 | 0 | |
| 2-JMS099.30 | 8/20/2007 | S | 1 | 27.7 | 7.1 | 4.1 | | 4.3 | 0 | 0.7 |
| 2-JMS099.30 | 8/20/2007 | M | 2 | 27.7 | 7.1 | 4.1 | | 4.3 | 0 | |
| 2-JMS099.30 | 8/20/2007 | M | 3 | 27.7 | 7.1 | 4.1 | | 4.3 | 0 | |
| 2-JMS099.30 | 8/20/2007 | M | 4 | 27.7 | 7 | 4.2 | | 4.3 | 0 | |
| 2-JMS099.30 | 8/20/2007 | M | 5 | 27.7 | 7.1 | 4.1 | | 4.3 | 0 | |
| 2-JMS099.30 | 8/20/2007 | M | 6 | 27.7 | 7.1 | 4.1 | | 4.3 | 0 | |
| 2-JMS099.30 | 8/20/2007 | M | 7 | 27.7 | 7.1 | 4.1 | | 4.3 | 0 | |
| 2-JMS099.30 | 8/20/2007 | M | 8 | 27.7 | 7.1 | 4.2 | | 4.3 | 0 | |
| 2-JMS099.30 | 8/20/2007 | B | 9 | 27.7 | 7 | 4.2 | | 4.3 | 0 | |
| 2-JMS099.30 | 9/24/2007 | S | 1 | 29.8 | 8.6 | 10.2 | | | 0 | 0.6 |
| 2-JMS099.30 | 9/24/2007 | M | 2 | 28.1 | 8.3 | 9.4 | | | 0 | |
| 2-JMS099.30 | 9/24/2007 | M | 3 | 27.5 | 8.4 | 10 | | | 0 | |
| 2-JMS099.30 | 9/24/2007 | M | 4 | 26.9 | 8.2 | 9.1 | | | 0 | |
| 2-JMS099.30 | 9/24/2007 | M | 5 | 26.7 | 8.2 | 9 | | | 0 | |
| 2-JMS099.30 | 9/24/2007 | M | 6 | 26.7 | 8.1 | 8.7 | | | 0 | |
| 2-JMS099.30 | 9/24/2007 | M | 7 | 25.2 | 7.8 | 7.4 | | | 0 | |
| 2-JMS099.30 | 9/24/2007 | M | 8 | 25.1 | 7.8 | 7.4 | | | 0 | |
| 2-JMS099.30 | 9/24/2007 | M | 9 | 25.1 | 7.8 | 7.5 | | | 0 | |
| 2-JMS099.30 | 9/24/2007 | B | 10 | 25 | 7.8 | 7.5 | | | 0 | |
| 2-JMS099.30 | 10/22/2007 | S | 1 | 26.3 | 8.4 | 9.4 | | | | 0.5 |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 10/22/2007 | M | 2 | 25 | 8 | 8.5 | | | | |
| 2-JMS099.30 | 10/22/2007 | M | 3 | 24.5 | 8 | 8.3 | | | | |
| 2-JMS099.30 | 10/22/2007 | M | 4 | 24 | 7.8 | 7.7 | | | | |
| 2-JMS099.30 | 10/22/2007 | M | 5 | 23.7 | 7.8 | 7.6 | | | | |
| 2-JMS099.30 | 10/22/2007 | M | 6 | 23.4 | 7.8 | 7.5 | | | | |
| 2-JMS099.30 | 10/22/2007 | M | 7 | 23.3 | 7.8 | 7.5 | | | | |
| 2-JMS099.30 | 10/22/2007 | M | 8 | 23.3 | 7.8 | 7.5 | | | | |
| 2-JMS099.30 | 10/22/2007 | M | 9 | 23.3 | 7.8 | 7.5 | | | | |
| 2-JMS099.30 | 10/22/2007 | M | 10 | 23.3 | 7.8 | 7.6 | | | | |
| 2-JMS099.30 | 10/22/2007 | B | 11 | 23.3 | 7.8 | 7.6 | | | | |
| 2-JMS099.30 | 11/13/2007 | S | 1 | 11.9 | 7.6 | 9.5 | | | 0 | 1.4 |
| 2-JMS099.30 | 11/13/2007 | M | 2 | 11.8 | 7.6 | 9.6 | | | 0 | |
| 2-JMS099.30 | 11/13/2007 | M | 3 | 11.8 | 7.6 | 9.6 | | | 0 | |
| 2-JMS099.30 | 11/13/2007 | M | 4 | 11.7 | 7.6 | 9.6 | | | 0 | |
| 2-JMS099.30 | 11/13/2007 | M | 5 | 11.7 | 7.6 | 9.6 | | | 0 | |
| 2-JMS099.30 | 11/13/2007 | M | 6 | 11.7 | 7.6 | 9.6 | | | 0 | |
| 2-JMS099.30 | 11/13/2007 | M | 7 | 11.7 | 7.6 | 9.6 | | | 0 | |
| 2-JMS099.30 | 11/13/2007 | M | 8 | 11.7 | 7.6 | 9.7 | | | 0 | |
| 2-JMS099.30 | 11/13/2007 | M | 9 | 11.7 | 7.6 | 9.7 | | | 0 | |
| 2-JMS099.30 | 11/13/2007 | B | 10 | 11.6 | 7.6 | 9.8 | | | 0 | |
| 2-JMS099.30 | 12/10/2007 | S | 1 | 7.6 | 7.4 | 11.2 | | | 0 | 1.5 |
| 2-JMS099.30 | 12/10/2007 | M | 2 | 7.7 | 7.4 | 11.1 | | | 0 | |
| 2-JMS099.30 | 12/10/2007 | M | 3 | 7.6 | 7.4 | 11 | | | 0 | |
| 2-JMS099.30 | 12/10/2007 | M | 4 | 7.5 | 7.4 | 11.1 | | | 0 | |
| 2-JMS099.30 | 12/10/2007 | M | 5 | 7.5 | 7.4 | 11 | | | 0 | |
| 2-JMS099.30 | 12/10/2007 | M | 6 | 7.6 | 7.4 | 11 | | | 0 | |
| 2-JMS099.30 | 12/10/2007 | M | 7 | 7.6 | 7.4 | 11 | | | 0 | |
| 2-JMS099.30 | 12/10/2007 | M | 8 | 7.6 | 7.4 | 11 | | | 0 | |
| 2-JMS099.30 | 12/10/2007 | M | 9 | 7.7 | 7.4 | 11.1 | | | 0 | |
| 2-JMS099.30 | 12/10/2007 | B | 10 | 7.8 | 7.4 | 11.2 | | | 0 | |
| 2-JMS099.30 | 1/23/2008 | S | 0 | | | | | | | |
| 2-JMS099.30 | 1/23/2008 | S | 1 | 3.4 | 7.2 | 13.1 | | | 0 | 1.4 |
| 2-JMS099.30 | 1/23/2008 | M | 2 | 3.4 | 7.2 | 13.1 | | | 0 | |
| 2-JMS099.30 | 1/23/2008 | M | 3 | 3.4 | 7.2 | 13.1 | | | 0 | |
| 2-JMS099.30 | 1/23/2008 | M | 4 | 3.4 | 7.2 | 13.1 | | | 0 | |
| 2-JMS099.30 | 1/23/2008 | M | 5 | 3.4 | 7.2 | 13.2 | | | 0 | |
| 2-JMS099.30 | 1/23/2008 | M | 6 | 3.4 | 7.2 | 13.2 | | | 0 | |
| 2-JMS099.30 | 1/23/2008 | M | 7 | 3.4 | 7.2 | 13.2 | | | 0 | |
| 2-JMS099.30 | 1/23/2008 | M | 8 | 3.4 | 7.2 | 13.4 | | | 0 | |
| 2-JMS099.30 | 1/23/2008 | M | 9 | 3.4 | 7.2 | 13.4 | | | 0 | |
| 2-JMS099.30 | 1/23/2008 | B | 10 | 3.4 | 7.3 | 13.4 | | | 0 | |
| 2-JMS099.30 | 2/14/2008 | S | 1 | 6.2 | 6.9 | 11.8 | | | 0 | 1.2 |
| 2-JMS099.30 | 2/14/2008 | M | 2 | 6.1 | 6.9 | 11.8 | | | 0 | |
| 2-JMS099.30 | 2/14/2008 | M | 3 | 6.1 | 6.9 | 11.8 | | | 0 | |
| 2-JMS099.30 | 2/14/2008 | M | 4 | 6.1 | 6.8 | 11.8 | | | 0 | |
| 2-JMS099.30 | 2/14/2008 | M | 5 | 6.1 | 6.8 | 11.8 | | | 0 | |
| 2-JMS099.30 | 2/14/2008 | B | 6 | 6.2 | 6.9 | 11.9 | | | 0 | |
| 2-JMS099.30 | 3/18/2008 | S | 1 | 12 | 6.9 | 10.2 | | | 0 | 1.6 |
| 2-JMS099.30 | 3/18/2008 | M | 2 | 12 | 6.8 | 10.2 | | | 0 | |
| 2-JMS099.30 | 3/18/2008 | M | 3 | 11.9 | 6.8 | 10.2 | | | 0 | |
| 2-JMS099.30 | 3/18/2008 | M | 4 | 11.7 | 6.8 | 10.2 | | | 0 | |
| 2-JMS099.30 | 3/18/2008 | M | 5 | 11.7 | 6.8 | 10.2 | | | 0 | |
| 2-JMS099.30 | 3/18/2008 | M | 6 | 11.7 | 6.8 | 10.2 | | | 0 | |
| 2-JMS099.30 | 3/18/2008 | M | 7 | 11.7 | 6.8 | 10.2 | | | 0 | |
| 2-JMS099.30 | 3/18/2008 | M | 8 | 11.6 | 6.8 | 10.2 | | | 0 | |
| 2-JMS099.30 | 3/18/2008 | M | 9 | 11.6 | 6.8 | 10.2 | | | 0 | |
| 2-JMS099.30 | 3/18/2008 | B | 10 | 11.6 | 6.7 | 10.3 | | | 0 | |
| 2-JMS099.30 | 4/15/2008 | S | 1 | 16.2 | 6.8 | 8.7 | | | 0 | 1.2 |
| 2-JMS099.30 | 4/15/2008 | M | 2 | 16 | 6.7 | 8.7 | | | 0 | |
| 2-JMS099.30 | 4/15/2008 | M | 3 | 16 | 6.7 | 8.7 | | | 0 | |
| 2-JMS099.30 | 4/15/2008 | M | 4 | 16 | 6.7 | 8.6 | | | 0 | |
| 2-JMS099.30 | 4/15/2008 | M | 5 | 16 | 6.7 | 8.6 | | | 0 | |
| 2-JMS099.30 | 4/15/2008 | M | 6 | 16 | 6.7 | 8.6 | | | 0 | |
| 2-JMS099.30 | 4/15/2008 | M | 7 | 15.9 | 6.7 | 8.6 | | | 0 | |
| 2-JMS099.30 | 4/15/2008 | B | 8 | 15.9 | 6.6 | | | | 0 | |
| 2-JMS099.30 | 5/22/2008 | S | 1 | 20 | 7.7 | 8.7 | | | | 0.9 |
| 2-JMS099.30 | 5/22/2008 | M | 2 | 19.9 | 7.7 | 8.7 | | | | |
| 2-JMS099.30 | 5/22/2008 | M | 3 | 19.8 | 7.7 | 8.7 | | | | |
| 2-JMS099.30 | 5/22/2008 | M | 4 | 19.8 | 7.7 | 8.7 | | | | |
| 2-JMS099.30 | 5/22/2008 | M | 5 | 19.8 | 7.7 | 8.7 | | | | |
| 2-JMS099.30 | 5/22/2008 | M | 6 | 19.8 | 7.7 | 8.7 | | | | |
| 2-JMS099.30 | 5/22/2008 | M | 7 | 19.7 | 7.7 | 8.7 | | | | |
| 2-JMS099.30 | 5/22/2008 | M | 8 | 19.7 | 7.7 | 8.7 | | | | |
| 2-JMS099.30 | 5/22/2008 | M | 9 | 19.7 | 7.7 | 8.7 | | | | |
| 2-JMS099.30 | 5/22/2008 | B | 10 | 19.7 | 7.7 | 8.7 | | | | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 6/17/2008 | S | 1 | 30.8 | 7.5 | 6.2 | | | 0 | 1 |
| 2-JMS099.30 | 6/17/2008 | M | 2 | 30.4 | 7.3 | 5.1 | | | 0 | |
| 2-JMS099.30 | 6/17/2008 | M | 3 | 30.4 | 7.4 | 5.2 | | | 0 | |
| 2-JMS099.30 | 6/17/2008 | M | 4 | 30.3 | 7.3 | 5 | | | 0 | |
| 2-JMS099.30 | 6/17/2008 | M | 5 | 30.3 | 7.3 | 4.9 | | | 0 | |
| 2-JMS099.30 | 6/17/2008 | M | 6 | 30.3 | 7.3 | 4.9 | | | 0 | |
| 2-JMS099.30 | 6/17/2008 | M | 7 | 30.3 | 7.3 | 4.9 | | | 0 | |
| 2-JMS099.30 | 6/17/2008 | M | 8 | 30.3 | 7.3 | 5 | | | 0 | |
| 2-JMS099.30 | 6/17/2008 | M | 9 | 30.3 | 7.3 | 5 | | | 0 | |
| 2-JMS099.30 | 6/17/2008 | M | 10 | 30.3 | 7.3 | 5.1 | | | 0 | |
| 2-JMS099.30 | 6/17/2008 | B | 11 | 30.3 | 7.3 | 5.1 | | | 0 | |
| 2-JMS099.30 | 7/15/2008 | S | 1 | 29.4 | 7.7 | 6.5 | | | 0 | 0.8 |
| 2-JMS099.30 | 7/15/2008 | M | 2 | 28.8 | 7.6 | 6.5 | | | 0 | |
| 2-JMS099.30 | 7/15/2008 | M | 3 | 28.5 | 7.5 | 5.8 | | | 0 | |
| 2-JMS099.30 | 7/15/2008 | M | 4 | 28.4 | 7.5 | 5.8 | | | 0 | |
| 2-JMS099.30 | 7/15/2008 | M | 5 | 28.3 | 7.5 | 5.7 | | | 0 | |
| 2-JMS099.30 | 7/15/2008 | M | 6 | 28.3 | 7.5 | 5.6 | | | 0 | |
| 2-JMS099.30 | 7/15/2008 | M | 7 | 28.3 | 7.5 | 5.6 | | | 0 | |
| 2-JMS099.30 | 7/15/2008 | M | 8 | 28.3 | 7.5 | 5.6 | | | 0 | |
| 2-JMS099.30 | 7/15/2008 | M | 9 | 28.3 | 7.5 | 5.6 | | | 0 | |
| 2-JMS099.30 | 7/15/2008 | B | 10 | 28.3 | 7.5 | 5.7 | | | 0 | |
| 2-JMS099.30 | 9/16/2008 | S | 1 | 26.8 | 7.2 | 6 | | | 0 | 0.7 |
| 2-JMS099.30 | 9/16/2008 | M | 2 | 26.7 | 7.2 | 6 | | | 0 | |
| 2-JMS099.30 | 9/16/2008 | M | 3 | 26.7 | 7.2 | 6 | | | 0 | |
| 2-JMS099.30 | 9/16/2008 | M | 4 | 26.7 | 7.2 | 6 | | | 0 | |
| 2-JMS099.30 | 9/16/2008 | M | 5 | 26.7 | 7.2 | 6 | | | 0 | |
| 2-JMS099.30 | 9/16/2008 | B | 6 | 26.6 | 7.2 | 5.9 | | | 0 | |
| 2-JMS099.30 | 10/21/2008 | S | 1 | 19.3 | 7.7 | 8 | | | 0 | 0.9 |
| 2-JMS099.30 | 10/21/2008 | M | 2 | 19.2 | 7.7 | 7.8 | | | 0 | |
| 2-JMS099.30 | 10/21/2008 | M | 3 | 19.2 | 7.7 | 7.7 | | | 0 | |
| 2-JMS099.30 | 10/21/2008 | M | 4 | 19.2 | 7.7 | 7.6 | | | 0 | |
| 2-JMS099.30 | 10/21/2008 | M | 5 | 19.2 | 7.7 | 7.5 | | | 0 | |
| 2-JMS099.30 | 10/21/2008 | M | 6 | 19.2 | 7.7 | 7.5 | | | 0 | |
| 2-JMS099.30 | 10/21/2008 | M | 7 | 19.2 | 7.7 | 7.6 | | | 0 | |
| 2-JMS099.30 | 10/21/2008 | M | 8 | 19.2 | 7.7 | 7.7 | | | 0 | |
| 2-JMS099.30 | 10/21/2008 | M | 9 | 19.2 | 7.6 | 7.9 | | | 0 | |
| 2-JMS099.30 | 10/21/2008 | B | 10 | 19.1 | 7.6 | 8.1 | | | 0 | |
| 2-JMS099.30 | 11/24/2008 | S | 1 | 8 | 7.8 | 11.8 | | | 0 | 1.3 |
| 2-JMS099.30 | 11/24/2008 | M | 2 | 8.1 | 7.8 | 11.8 | | | 0 | |
| 2-JMS099.30 | 11/24/2008 | M | 3 | 7.8 | 7.8 | 11.8 | | | 0 | |
| 2-JMS099.30 | 11/24/2008 | M | 4 | 7.7 | 7.8 | 11.8 | | | 0 | |
| 2-JMS099.30 | 11/24/2008 | M | 5 | 7.6 | 7.8 | 11.9 | | | 0 | |
| 2-JMS099.30 | 11/24/2008 | M | 6 | 7.6 | 7.8 | 12 | | | 0 | |
| 2-JMS099.30 | 11/24/2008 | M | 7 | 7.6 | 7.8 | 11.9 | | | 0 | |
| 2-JMS099.30 | 11/24/2008 | M | 8 | 7.6 | 7.8 | 11.9 | | | 0 | |
| 2-JMS099.30 | 11/24/2008 | M | 9 | 7.6 | 7.9 | 11.9 | | | 0 | |
| 2-JMS099.30 | 11/24/2008 | M | 10 | 7.6 | 7.9 | 12 | | | 0 | |
| 2-JMS099.30 | 11/24/2008 | M | 11 | 7.5 | 7.9 | 12 | | | 0 | |
| 2-JMS099.30 | 11/24/2008 | B | 12 | 7.5 | 7.9 | 12.1 | | | 0 | |
| 2-JMS099.30 | 12/9/2008 | S | 1 | 5.6 | 7.9 | 13.1 | | | 0 | 1.8 |
| 2-JMS099.30 | 12/9/2008 | M | 2 | 5.5 | 7.9 | 13.1 | | | 0 | |
| 2-JMS099.30 | 12/9/2008 | M | 3 | 5.4 | 7.9 | 13.1 | | | 0 | |
| 2-JMS099.30 | 12/9/2008 | M | 4 | 5.4 | 7.9 | 13.1 | | | 0 | |
| 2-JMS099.30 | 12/9/2008 | M | 5 | 5.4 | 8 | 13.2 | | | 0 | |
| 2-JMS099.30 | 12/9/2008 | M | 6 | 5.3 | 8 | 13.2 | | | 0 | |
| 2-JMS099.30 | 12/9/2008 | M | 7 | 5.3 | 8 | 13.4 | | | 0 | |
| 2-JMS099.30 | 12/9/2008 | M | 8 | 5.3 | 8.1 | 13.4 | | | 0 | |
| 2-JMS099.30 | 12/9/2008 | B | 9 | 5.3 | 8.1 | 13.4 | | | 0 | |
| 2-JMS099.30 | 1/21/2009 | S | 1 | 1 | 7.4 | 13.7 | | | 0 | 0.7 |
| 2-JMS099.30 | 1/21/2009 | M | 2 | 1 | 7.4 | 13.8 | | | 0 | |
| 2-JMS099.30 | 1/21/2009 | M | 3 | 1 | 7.4 | 13.8 | | | 0 | |
| 2-JMS099.30 | 1/21/2009 | M | 4 | 1 | 7.4 | 13.8 | | | 0 | |
| 2-JMS099.30 | 1/21/2009 | M | 5 | 1 | 7.4 | 13.9 | | | 0 | |
| 2-JMS099.30 | 1/21/2009 | M | 6 | 1 | 7.4 | 14 | | | 0 | |
| 2-JMS099.30 | 1/21/2009 | M | 7 | 1 | 7.4 | 14 | | | 0 | |
| 2-JMS099.30 | 1/21/2009 | M | 8 | 1 | 7.4 | 14 | | | 0 | |
| 2-JMS099.30 | 1/21/2009 | B | 9 | 1 | 7.4 | 14 | | | 0 | |
| 2-JMS099.30 | 2/19/2009 | S | 1 | 7.5 | 6.3 | 11.3 | | | 0 | 1.1 |
| 2-JMS099.30 | 2/19/2009 | M | 2 | 7.5 | 6.3 | 11.3 | | | 0 | |
| 2-JMS099.30 | 2/19/2009 | M | 3 | 7.5 | 6.2 | 11.3 | | | 0 | |
| 2-JMS099.30 | 2/19/2009 | M | 4 | 7.5 | 6.1 | 11.3 | | | 0 | |
| 2-JMS099.30 | 2/19/2009 | M | 5 | 7.5 | 6 | 11.3 | | | 0 | |
| 2-JMS099.30 | 2/19/2009 | M | 6 | 7.5 | 5.8 | 11.3 | | | 0 | |
| 2-JMS099.30 | 2/19/2009 | M | 7 | 7.5 | 5.8 | 11.3 | | | 0 | |
| 2-JMS099.30 | 2/19/2009 | M | 8 | 7.4 | 5.6 | 11.2 | | | 0 | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 2/19/2009 | M | 9 | 7.4 | 4.8 | 10.6 | | | 0 | |
| 2-JMS099.30 | 2/19/2009 | M | 10 | 7.3 | 4.8 | 10.5 | | | 0 | |
| 2-JMS099.30 | 2/19/2009 | B | 11 | 7.4 | 4.7 | 10.6 | | | 0 | |
| 2-JMS099.30 | 3/17/2009 | S | 1 | 9.6 | 7.4 | 10.5 | | | 0 | 1.1 |
| 2-JMS099.30 | 3/17/2009 | M | 2 | 9.6 | 7.4 | 10.6 | | | 0 | |
| 2-JMS099.30 | 3/17/2009 | M | 3 | 9.6 | 7.5 | 10.6 | | | 0 | |
| 2-JMS099.30 | 3/17/2009 | M | 4 | 9.6 | 7.5 | 10.7 | | | 0 | |
| 2-JMS099.30 | 3/17/2009 | M | 5 | 9.5 | 7.5 | 10.7 | | | 0 | |
| 2-JMS099.30 | 3/17/2009 | M | 6 | 9.5 | 7.5 | 10.8 | | | 0 | |
| 2-JMS099.30 | 3/17/2009 | M | 7 | 9.5 | 7.5 | 10.8 | | | 0 | |
| 2-JMS099.30 | 3/17/2009 | M | 8 | 9.5 | 7.5 | 11 | | | 0 | |
| 2-JMS099.30 | 3/17/2009 | M | 9 | 9.5 | 7.5 | 10.9 | | | 0 | |
| 2-JMS099.30 | 3/17/2009 | B | 10 | 9.5 | 7.4 | 11.1 | | | 0 | |
| 2-JMS099.30 | 4/30/2009 | S | 1 | 21.1 | 7.4 | 8.4 | | | | 1.2 |
| 2-JMS099.30 | 4/30/2009 | M | 2 | 21 | 7.4 | 8.4 | | | | |
| 2-JMS099.30 | 4/30/2009 | M | 3 | 21 | 7.4 | 8.4 | | | | |
| 2-JMS099.30 | 4/30/2009 | M | 4 | 21 | 7.4 | 8.5 | | | | |
| 2-JMS099.30 | 4/30/2009 | M | 5 | 21 | 7.4 | 8.5 | | | | |
| 2-JMS099.30 | 4/30/2009 | M | 6 | 21 | 7.4 | 8.5 | | | | |
| 2-JMS099.30 | 4/30/2009 | M | 7 | 20.9 | 7.4 | 8.5 | | | | |
| 2-JMS099.30 | 4/30/2009 | B | 8 | 20.9 | 7.4 | 8.5 | | | | |
| 2-JMS099.30 | 5/19/2009 | S | 1 | 18.9 | 7.6 | 9.1 | | | | 0.2 |
| 2-JMS099.30 | 5/19/2009 | M | 2 | 18.9 | 7.6 | 9 | | | | |
| 2-JMS099.30 | 5/19/2009 | M | 3 | 18.9 | 7.6 | 9.2 | | | | |
| 2-JMS099.30 | 5/19/2009 | M | 4 | 18.9 | 7.6 | 9.3 | | | | |
| 2-JMS099.30 | 5/19/2009 | M | 5 | 18.9 | 7.7 | 9.3 | | | | |
| 2-JMS099.30 | 5/19/2009 | M | 6 | 18.9 | 7.7 | 9.3 | | | | |
| 2-JMS099.30 | 5/19/2009 | M | 7 | 18.8 | 7.7 | 9.4 | | | | |
| 2-JMS099.30 | 5/19/2009 | M | 8 | 18.8 | 7.7 | 9.4 | | | | |
| 2-JMS099.30 | 5/19/2009 | B | 9 | 18.8 | 7.7 | 9.5 | | | | |
| 2-JMS099.30 | 6/16/2009 | S | 1 | 26.7 | 7.4 | 7.4 | | | | 0.8 |
| 2-JMS099.30 | 6/16/2009 | M | 2 | 26.7 | 7.4 | 7.4 | | | | |
| 2-JMS099.30 | 6/16/2009 | M | 3 | 26.7 | 7.4 | 7.4 | | | | |
| 2-JMS099.30 | 6/16/2009 | M | 4 | 26.7 | 7.4 | 7.4 | | | | |
| 2-JMS099.30 | 6/16/2009 | M | 5 | 26.7 | 7.4 | 7.4 | | | | |
| 2-JMS099.30 | 6/16/2009 | M | 6 | 26.7 | 7.4 | 7.4 | | | | |
| 2-JMS099.30 | 6/16/2009 | M | 7 | 26.6 | 7.4 | 7.4 | | | | |
| 2-JMS099.30 | 6/16/2009 | M | 8 | 26.6 | 7.4 | 7.4 | | | | |
| 2-JMS099.30 | 6/16/2009 | M | 9 | 26.6 | 7.4 | 7.4 | | | | |
| 2-JMS099.30 | 6/16/2009 | B | 10 | 26.6 | 7.4 | 7.4 | | | | |
| 2-JMS099.30 | 7/21/2009 | S | 1 | 28.5 | 7.2 | 5.7 | | | | 1.2 |
| 2-JMS099.30 | 7/21/2009 | M | 2 | 28.4 | 7.2 | 5.7 | | | | |
| 2-JMS099.30 | 7/21/2009 | M | 3 | 28.4 | 7.2 | 5.7 | | | | |
| 2-JMS099.30 | 7/21/2009 | M | 4 | 28.4 | 7.2 | 5.7 | | | | |
| 2-JMS099.30 | 7/21/2009 | M | 5 | 28.4 | 7.2 | 5.7 | | | | |
| 2-JMS099.30 | 7/21/2009 | M | 6 | 28.3 | 7.2 | 5.6 | | | | |
| 2-JMS099.30 | 7/21/2009 | M | 7 | 28.1 | 7.1 | 5.4 | | | | |
| 2-JMS099.30 | 7/21/2009 | M | 8 | 28 | 7.1 | 5.3 | | | | |
| 2-JMS099.30 | 7/21/2009 | M | 9 | 28 | 7.1 | 5.3 | | | | |
| 2-JMS099.30 | 7/21/2009 | B | 10 | 28 | 7.1 | 5.4 | | | | |
| 2-JMS099.30 | 8/18/2009 | S | 1 | 32.4 | 8.2 | 7.2 | | | | 1.1 |
| 2-JMS099.30 | 8/18/2009 | M | 2 | 31.8 | 8.2 | 7 | | | | |
| 2-JMS099.30 | 8/18/2009 | M | 3 | 31.3 | 8.1 | 6.8 | | | | |
| 2-JMS099.30 | 8/18/2009 | M | 4 | 30.8 | 8 | 6.5 | | | | |
| 2-JMS099.30 | 8/18/2009 | M | 5 | 30.6 | 8 | 6.4 | | | | |
| 2-JMS099.30 | 8/18/2009 | M | 6 | 30.3 | 7.9 | 6.3 | | | | |
| 2-JMS099.30 | 8/18/2009 | M | 7 | 30.3 | 7.9 | 6.3 | | | | |
| 2-JMS099.30 | 8/18/2009 | M | 8 | 30.2 | 7.9 | 6.2 | | | | |
| 2-JMS099.30 | 8/18/2009 | M | 9 | 30.1 | 7.9 | 6.2 | | | | |
| 2-JMS099.30 | 8/18/2009 | M | 10 | 30.1 | 7.9 | 6.2 | | | | |
| 2-JMS099.30 | 8/18/2009 | M | 11 | 30 | 7.9 | 6.2 | | | | |
| 2-JMS099.30 | 8/18/2009 | B | 12 | 30 | 7.9 | 6.2 | | | | |
| 2-JMS099.30 | 9/15/2009 | S | 1 | 28.3 | 8.4 | | | | | 0.8 |
| 2-JMS099.30 | 9/15/2009 | M | 2 | 26.9 | 7.9 | | | | | |
| 2-JMS099.30 | 9/15/2009 | M | 3 | 25.7 | 7.7 | | | | | |
| 2-JMS099.30 | 9/15/2009 | M | 4 | 25.5 | 7.6 | | | | | |
| 2-JMS099.30 | 9/15/2009 | M | 5 | 25.5 | 7.6 | | | | | |
| 2-JMS099.30 | 9/15/2009 | M | 6 | 25.5 | 7.6 | | | | | |
| 2-JMS099.30 | 9/15/2009 | M | 7 | 25.4 | 7.6 | | | | | |
| 2-JMS099.30 | 9/15/2009 | B | 8 | 24.7 | 7.6 | | | | | |
| 2-JMS099.30 | 10/28/2009 | S | 1 | 16.8 | 7.7 | 8.4 | | | | 1.6 |
| 2-JMS099.30 | 10/28/2009 | M | 2 | 16.7 | 7.7 | 8.4 | | | | |
| 2-JMS099.30 | 10/28/2009 | M | 3 | 16.7 | 7.7 | 8.3 | | | | |
| 2-JMS099.30 | 10/28/2009 | M | 4 | 16.7 | 7.7 | 8.3 | | | | |
| 2-JMS099.30 | 10/28/2009 | M | 5 | 16.6 | 7.7 | 8.3 | | | | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 10/28/2009 | M | 6 | 16.6 | 7.7 | 8.3 | | | | |
| 2-JMS099.30 | 10/28/2009 | M | 7 | 16.6 | 7.7 | 8.3 | | | | |
| 2-JMS099.30 | 10/28/2009 | M | 8 | 16.6 | 7.7 | 8.4 | | | | |
| 2-JMS099.30 | 10/28/2009 | M | 9 | 16.6 | 7.7 | 8.5 | | | | |
| 2-JMS099.30 | 10/28/2009 | B | 10 | 16.6 | 7.7 | 8.5 | | | | |
| 2-JMS099.30 | 11/9/2009 | S | 1 | 13.1 | 7.7 | | | | | 1.1 |
| 2-JMS099.30 | 11/9/2009 | M | 2 | 12.9 | 7.7 | | | | | |
| 2-JMS099.30 | 11/9/2009 | M | 3 | 12.9 | 7.7 | | | | | |
| 2-JMS099.30 | 11/9/2009 | M | 4 | 12.8 | 7.7 | | | | | |
| 2-JMS099.30 | 11/9/2009 | M | 5 | 12.8 | 7.7 | | | | | |
| 2-JMS099.30 | 11/9/2009 | M | 6 | 12.8 | 7.8 | | | | | |
| 2-JMS099.30 | 11/9/2009 | M | 7 | 12.8 | 7.8 | | | | | |
| 2-JMS099.30 | 11/9/2009 | M | 8 | 12.8 | 7.9 | | | | | |
| 2-JMS099.30 | 11/9/2009 | B | 9 | 12.9 | 7.9 | | | | | |
| 2-JMS099.30 | 12/8/2009 | S | 1 | 6.8 | 6.9 | 11.9 | | | | 0.5 |
| 2-JMS099.30 | 12/8/2009 | M | 2 | 6.8 | 6.8 | 11.9 | | | | |
| 2-JMS099.30 | 12/8/2009 | M | 3 | 6.8 | 6.8 | 11.9 | | | | |
| 2-JMS099.30 | 12/8/2009 | M | 4 | 6.8 | 6.8 | 11.9 | | | | |
| 2-JMS099.30 | 12/8/2009 | M | 5 | 6.8 | 6.8 | 11.9 | | | | |
| 2-JMS099.30 | 12/8/2009 | M | 6 | 6.8 | 6.8 | 12 | | | | |
| 2-JMS099.30 | 12/8/2009 | M | 7 | 6.8 | 6.7 | 11.9 | | | | |
| 2-JMS099.30 | 12/8/2009 | B | 8 | 6.8 | 6.7 | 11.9 | | | | |
| 2-JMS099.30 | 1/25/2010 | S | 0 | | | | | | | |
| 2-JMS099.30 | 1/25/2010 | S | 1 | 7.4 | 7.5 | 11.4 | | | | 0.3 |
| 2-JMS099.30 | 1/25/2010 | M | 2 | 7.4 | 7.5 | 11.3 | | | | |
| 2-JMS099.30 | 1/25/2010 | M | 3 | 7.3 | 7.5 | 11.3 | | | | |
| 2-JMS099.30 | 1/25/2010 | M | 4 | 7.3 | 7.4 | 11.1 | | | | |
| 2-JMS099.30 | 1/25/2010 | M | 5 | 7.3 | 7.4 | 11.1 | | | | |
| 2-JMS099.30 | 1/25/2010 | M | 6 | 7.3 | 7.4 | 11 | | | | |
| 2-JMS099.30 | 1/25/2010 | M | 7 | 7.3 | 7.4 | 10.9 | | | | |
| 2-JMS099.30 | 1/25/2010 | M | 8 | 7.3 | 7.4 | 10.9 | | | | |
| 2-JMS099.30 | 1/25/2010 | M | 9 | 7.3 | 7.4 | 10.9 | | | | |
| 2-JMS099.30 | 1/25/2010 | M | 10 | 7.4 | 7.4 | 10.9 | | | | |
| 2-JMS099.30 | 1/25/2010 | B | 11 | 7.4 | 7.4 | 10.7 | | | | |
| 2-JMS099.30 | 2/17/2010 | S | 1 | 3.5 | 7.6 | 12.4 | | | | 1 |
| 2-JMS099.30 | 2/17/2010 | M | 2 | 3.5 | 7.6 | 12.4 | | | | |
| 2-JMS099.30 | 2/17/2010 | M | 3 | 3.5 | 7.6 | 12.4 | | | | |
| 2-JMS099.30 | 2/17/2010 | M | 4 | 3.5 | 7.6 | 12.3 | | | | |
| 2-JMS099.30 | 2/17/2010 | M | 5 | 3.5 | 7.5 | 12.3 | | | | |
| 2-JMS099.30 | 2/17/2010 | M | 6 | 3.5 | 7.5 | 12.3 | | | | |
| 2-JMS099.30 | 2/17/2010 | M | 7 | 3.5 | 7.5 | 12.3 | | | | |
| 2-JMS099.30 | 2/17/2010 | M | 8 | 3.6 | 7.5 | 12.3 | | | | |
| 2-JMS099.30 | 2/17/2010 | B | 9 | 3.7 | 7.5 | 12.3 | | | | |
| 2-JMS099.30 | 3/4/2010 | S | 1 | 5.7 | 7.6 | 12.6 | | | | 1.2 |
| 2-JMS099.30 | 3/4/2010 | M | 2 | 5.7 | 7.6 | 12.7 | | | | |
| 2-JMS099.30 | 3/4/2010 | M | 3 | 5.7 | 7.5 | 12.7 | | | | |
| 2-JMS099.30 | 3/4/2010 | M | 4 | 5.7 | 7.5 | 12.7 | | | | |
| 2-JMS099.30 | 3/4/2010 | M | 5 | 5.7 | 7.5 | 12.7 | | | | |
| 2-JMS099.30 | 3/4/2010 | M | 6 | 5.7 | 7.5 | 12.7 | | | | |
| 2-JMS099.30 | 3/4/2010 | M | 7 | 5.6 | 7.5 | 12.7 | | | | |
| 2-JMS099.30 | 3/4/2010 | M | 8 | 5.6 | 7.4 | 12.8 | | | | |
| 2-JMS099.30 | 3/4/2010 | M | 9 | 5.6 | 7.4 | 12.8 | | | | |
| 2-JMS099.30 | 3/4/2010 | B | 10 | 5.6 | 7.4 | 12.8 | | | | |
| 2-JMS099.30 | 4/6/2010 | S | 1 | 18.1 | 7.5 | 9.3 | | | | 1.1 |
| 2-JMS099.30 | 4/6/2010 | M | 2 | 18 | 7.5 | 9.4 | | | | |
| 2-JMS099.30 | 4/6/2010 | M | 3 | 18.1 | 7.5 | 9.4 | | | | |
| 2-JMS099.30 | 4/6/2010 | M | 4 | 17.7 | 7.4 | 9.4 | | | | |
| 2-JMS099.30 | 4/6/2010 | M | 5 | 17.7 | 7.4 | 9.4 | | | | |
| 2-JMS099.30 | 4/6/2010 | M | 6 | 17.7 | 7.4 | 9.4 | | | | |
| 2-JMS099.30 | 4/6/2010 | M | 7 | 17.7 | 7.4 | 9.4 | | | | |
| 2-JMS099.30 | 4/6/2010 | M | 8 | 17.7 | 7.4 | 9.4 | | | | |
| 2-JMS099.30 | 4/6/2010 | M | 9 | 17.7 | 7.4 | 9.4 | | | | |
| 2-JMS099.30 | 4/6/2010 | B | 10 | 17.7 | 7.4 | 9.4 | | | | |
| 2-JMS099.30 | 5/4/2010 | S | 1 | 23.7 | 8 | | | | | 0.7 |
| 2-JMS099.30 | 5/4/2010 | M | 2 | 23.6 | 8 | | | | | |
| 2-JMS099.30 | 5/4/2010 | M | 3 | 23.5 | 7.9 | | | | | |
| 2-JMS099.30 | 5/4/2010 | M | 4 | 23.5 | 7.9 | | | | | |
| 2-JMS099.30 | 5/4/2010 | M | 5 | 23.3 | 7.9 | | | | | |
| 2-JMS099.30 | 5/4/2010 | M | 6 | 23.3 | 7.9 | | | | | |
| 2-JMS099.30 | 5/4/2010 | M | 7 | 23.3 | 7.8 | | | | | |
| 2-JMS099.30 | 5/4/2010 | M | 8 | 23.3 | 7.8 | | | | | |
| 2-JMS099.30 | 5/4/2010 | B | 9 | 23.3 | 7.8 | | | | | |
| 2-JMS099.30 | 6/2/2010 | S | 1 | 27.5 | 7.5 | | | | | 0.5 |
| 2-JMS099.30 | 6/2/2010 | M | 2 | 27.1 | 7.5 | | | | | |
| 2-JMS099.30 | 6/2/2010 | M | 3 | 26.8 | 7.4 | | | | | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 6/2/2010 | M | 4 | 26.8 | 7.3 | | | | | |
| 2-JMS099.30 | 6/2/2010 | M | 5 | 26.8 | 7.3 | | | | | |
| 2-JMS099.30 | 6/2/2010 | M | 6 | 26.8 | 7.3 | | | | | |
| 2-JMS099.30 | 6/2/2010 | M | 7 | 26.7 | 7.3 | | | | | |
| 2-JMS099.30 | 6/2/2010 | B | 8 | 26.6 | 7.3 | | | | | |
| 2-JMS099.30 | 7/7/2010 | S | 1 | 33.7 | 8.1 | 8.6 | | | | 0.9 |
| 2-JMS099.30 | 7/7/2010 | M | 2 | 32.9 | 7.9 | 8.1 | | | | |
| 2-JMS099.30 | 7/7/2010 | M | 3 | 32.5 | 7.6 | 7.6 | | | | |
| 2-JMS099.30 | 7/7/2010 | M | 4 | 30.8 | 7.4 | 6 | | | | |
| 2-JMS099.30 | 7/7/2010 | M | 5 | 30 | 7.3 | 5.6 | | | | |
| 2-JMS099.30 | 7/7/2010 | M | 6 | 29.6 | 7.3 | 5.3 | | | | |
| 2-JMS099.30 | 7/7/2010 | M | 7 | 29.5 | 7.3 | 5.4 | | | | |
| 2-JMS099.30 | 7/7/2010 | M | 8 | 29.5 | 7.3 | 5.4 | | | | |
| 2-JMS099.30 | 7/7/2010 | M | 9 | 29.5 | 7.3 | 5.4 | | | | |
| 2-JMS099.30 | 7/7/2010 | B | 10 | 29.4 | 7.3 | 5.4 | | | | |
| 2-JMS099.30 | 8/3/2010 | S | 1 | 29.9 | 7.5 | 6.2 | | | | 0.9 |
| 2-JMS099.30 | 8/3/2010 | M | 2 | 29.7 | 7.5 | 5.9 | | | | |
| 2-JMS099.30 | 8/3/2010 | M | 3 | 29.7 | 7.5 | 5.8 | | | | |
| 2-JMS099.30 | 8/3/2010 | M | 4 | 29.7 | 7.5 | 5.8 | | | | |
| 2-JMS099.30 | 8/3/2010 | M | 5 | 29.7 | 7.5 | 5.8 | | | | |
| 2-JMS099.30 | 8/3/2010 | M | 6 | 29.7 | 7.5 | 5.8 | | | | |
| 2-JMS099.30 | 8/3/2010 | M | 7 | 29.7 | 7.5 | 5.7 | | | | |
| 2-JMS099.30 | 8/3/2010 | M | 8 | 29.7 | 7.5 | 5.6 | | | | |
| 2-JMS099.30 | 8/3/2010 | B | 9 | 29.6 | 7.5 | 5.6 | | | | |
| 2-JMS099.30 | 9/8/2010 | S | 1 | 29.2 | 8 | 7.4 | | | | 0.7 |
| 2-JMS099.30 | 9/8/2010 | M | 2 | 28.9 | 7.7 | 6.7 | | | | |
| 2-JMS099.30 | 9/8/2010 | M | 3 | 28.8 | 7.7 | 6.5 | | | | |
| 2-JMS099.30 | 9/8/2010 | M | 4 | 28.8 | 7.7 | 6.4 | | | | |
| 2-JMS099.30 | 9/8/2010 | M | 5 | 28.8 | 7.7 | 6.6 | | | | |
| 2-JMS099.30 | 9/8/2010 | M | 6 | 28.8 | 7.7 | 6.6 | | | | |
| 2-JMS099.30 | 9/8/2010 | M | 7 | 28.8 | 7.7 | 6.7 | | | | |
| 2-JMS099.30 | 9/8/2010 | M | 8 | 28.8 | 7.7 | 6.7 | | | | |
| 2-JMS099.30 | 9/8/2010 | M | 9 | 28.9 | 7.8 | 6.7 | | | | |
| 2-JMS099.30 | 9/8/2010 | B | 10 | 28.9 | 7.8 | 6.7 | | | | |
| 2-JMS099.30 | 10/5/2010 | S | 1 | 18.5 | 7.7 | | | 9.2 | | 0.6 |
| 2-JMS099.30 | 10/5/2010 | M | 2 | 18.4 | 7.7 | | | 9.2 | | |
| 2-JMS099.30 | 10/5/2010 | M | 3 | 18.4 | 7.7 | | | 9.1 | | |
| 2-JMS099.30 | 10/5/2010 | M | 4 | 18.4 | 7.7 | | | 9.1 | | |
| 2-JMS099.30 | 10/5/2010 | M | 5 | 18.4 | 7.7 | | | 9.1 | | |
| 2-JMS099.30 | 10/5/2010 | M | 6 | 18.4 | 7.7 | | | 9.1 | | |
| 2-JMS099.30 | 10/5/2010 | M | 7 | 18.4 | 7.7 | | | 9.1 | | |
| 2-JMS099.30 | 10/5/2010 | M | 8 | 18.4 | 7.7 | | | 9.1 | | |
| 2-JMS099.30 | 10/5/2010 | M | 9 | 18.4 | 7.8 | | | 9.1 | | |
| 2-JMS099.30 | 10/5/2010 | M | 10 | 18.3 | 7.8 | | | 9 | | |
| 2-JMS099.30 | 10/5/2010 | B | 11 | 18.3 | 7.7 | | | 9 | | |
| 2-JMS099.30 | 11/2/2010 | S | 1 | 16.1 | 7.7 | 9.8 | | | 0 | 1.4 |
| 2-JMS099.30 | 11/2/2010 | M | 2 | 16 | 7.7 | 9.8 | | | 0 | |
| 2-JMS099.30 | 11/2/2010 | M | 3 | 15.9 | 7.7 | 9.8 | | | 0 | |
| 2-JMS099.30 | 11/2/2010 | M | 4 | 15.9 | 7.7 | 9.9 | | | 0 | |
| 2-JMS099.30 | 11/2/2010 | M | 5 | 15.8 | 7.7 | 10 | | | 0 | |
| 2-JMS099.30 | 11/2/2010 | M | 6 | 15.8 | 7.7 | 10 | | | 0 | |
| 2-JMS099.30 | 11/2/2010 | M | 7 | 15.8 | 7.7 | 10 | | | 0 | |
| 2-JMS099.30 | 11/2/2010 | M | 8 | 15.8 | 7.7 | 10.2 | | | 0 | |
| 2-JMS099.30 | 11/2/2010 | M | 9 | 15.7 | 7.7 | 10.4 | | | 0 | |
| 2-JMS099.30 | 11/2/2010 | M | 10 | 15.7 | 7.7 | 10.5 | | | 0 | |
| 2-JMS099.30 | 11/2/2010 | M | 11 | 15.7 | 7.7 | 10.5 | | | 0 | |
| 2-JMS099.30 | 11/2/2010 | B | 12 | 15.7 | 7.8 | 10.5 | | | 0 | |
| 2-JMS099.30 | 1/4/2011 | S | 1 | 3.7 | 7.6 | 13.3 | | | | 1.8 |
| 2-JMS099.30 | 1/4/2011 | M | 2 | 3.7 | 7.6 | 13.4 | | | | |
| 2-JMS099.30 | 1/4/2011 | M | 3 | 3.6 | 7.6 | 13.4 | | | | |
| 2-JMS099.30 | 1/4/2011 | M | 4 | 3.6 | 7.6 | 13.4 | | | | |
| 2-JMS099.30 | 1/4/2011 | M | 5 | 3.6 | 7.6 | 13.4 | | | | |
| 2-JMS099.30 | 1/4/2011 | M | 6 | 3.6 | 7.6 | 13.4 | | | | |
| 2-JMS099.30 | 1/4/2011 | M | 7 | 3.6 | 7.6 | 13.4 | | | | |
| 2-JMS099.30 | 1/4/2011 | M | 8 | 3.6 | 7.6 | 13.5 | | | | |
| 2-JMS099.30 | 1/4/2011 | M | 9 | 3.6 | 7.6 | 13.5 | | | | |
| 2-JMS099.30 | 1/4/2011 | M | 10 | 3.6 | 7.6 | 13.5 | | | | |
| 2-JMS099.30 | 1/4/2011 | B | 11 | 3.6 | 7.6 | 13.5 | | | | |
| 2-JMS099.30 | 2/1/2011 | S | 1 | 3.8 | 7.4 | 12.8 | | | | 1.3 |
| 2-JMS099.30 | 2/1/2011 | M | 2 | 3.7 | 7.4 | 12.8 | | | | |
| 2-JMS099.30 | 2/1/2011 | M | 3 | 3.7 | 7.4 | 12.8 | | | | |
| 2-JMS099.30 | 2/1/2011 | M | 4 | 3.7 | 7.4 | 12.8 | | | | |
| 2-JMS099.30 | 2/1/2011 | M | 5 | 3.7 | 7.4 | 12.8 | | | | |
| 2-JMS099.30 | 2/1/2011 | M | 6 | 3.7 | 7.4 | 12.8 | | | | |
| 2-JMS099.30 | 2/1/2011 | M | 7 | 3.7 | 7.4 | 12.9 | | | | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 2/1/2011 | M | 8 | 3.7 | 7.4 | 12.8 | | | | |
| 2-JMS099.30 | 2/1/2011 | M | 9 | 3.7 | 7.3 | 12.8 | | | | |
| 2-JMS099.30 | 2/1/2011 | B | 10 | 3.7 | 7.3 | 12.9 | | | | |
| 2-JMS099.30 | 3/1/2011 | S | 1 | 10.8 | 7.4 | 10.6 | | | | 1.2 |
| 2-JMS099.30 | 3/1/2011 | M | 2 | 10.7 | 7.4 | 10.7 | | | | |
| 2-JMS099.30 | 3/1/2011 | M | 3 | 10.4 | 7.4 | 10.6 | | | | |
| 2-JMS099.30 | 3/1/2011 | M | 4 | 10.1 | 7.4 | 10.5 | | | | |
| 2-JMS099.30 | 3/1/2011 | M | 5 | 10.1 | 7.4 | 10.6 | | | | |
| 2-JMS099.30 | 3/1/2011 | M | 6 | 10 | 7.3 | 10.5 | | | | |
| 2-JMS099.30 | 3/1/2011 | M | 7 | 10 | 7.3 | 10.5 | | | | |
| 2-JMS099.30 | 3/1/2011 | M | 8 | 10 | 7.3 | 10.6 | | | | |
| 2-JMS099.30 | 3/1/2011 | M | 9 | 10 | 7.3 | 10.6 | | | | |
| 2-JMS099.30 | 3/1/2011 | M | 10 | 10 | 7.3 | 10.6 | | | | |
| 2-JMS099.30 | 3/1/2011 | B | 11 | 10 | 7.2 | 10.6 | | | | |
| 2-JMS099.30 | 4/14/2011 | S | 1 | 16.3 | 7.6 | 9.7 | | | | 1.3 |
| 2-JMS099.30 | 4/14/2011 | M | 2 | 16.3 | 7.6 | 9.7 | | | | |
| 2-JMS099.30 | 4/14/2011 | M | 3 | 16.4 | 7.6 | 9.7 | | | | |
| 2-JMS099.30 | 4/14/2011 | M | 4 | 16.4 | 7.6 | 9.8 | | | | |
| 2-JMS099.30 | 4/14/2011 | M | 5 | 16.4 | 7.6 | 9.8 | | | | |
| 2-JMS099.30 | 4/14/2011 | M | 6 | 16.4 | 7.6 | 9.8 | | | | |
| 2-JMS099.30 | 4/14/2011 | M | 7 | 16.3 | 7.6 | 9.8 | | | | |
| 2-JMS099.30 | 4/14/2011 | B | 8 | 16.2 | 7.6 | 9.7 | | | | |
| 2-JMS099.30 | 5/3/2011 | S | 1 | 19.2 | 7.4 | 9.5 | | | | 0.1 |
| 2-JMS099.30 | 5/3/2011 | M | 2 | 19.1 | 7.4 | 9.5 | | | | |
| 2-JMS099.30 | 5/3/2011 | M | 3 | 18.8 | 7.4 | 9.5 | | | | |
| 2-JMS099.30 | 5/3/2011 | M | 4 | 18.6 | 7.3 | 9.6 | | | | |
| 2-JMS099.30 | 5/3/2011 | M | 5 | 18.6 | 7.3 | 9.6 | | | | |
| 2-JMS099.30 | 5/3/2011 | M | 6 | 18.6 | 7.3 | 9.5 | | | | |
| 2-JMS099.30 | 5/3/2011 | M | 7 | 18.6 | 7.4 | 9.6 | | | | |
| 2-JMS099.30 | 5/3/2011 | M | 8 | 18.6 | 7.4 | 9.6 | | | | |
| 2-JMS099.30 | 5/3/2011 | M | 9 | 18.6 | 7.4 | 9.6 | | | | |
| 2-JMS099.30 | 5/3/2011 | B | 10 | 18.6 | 7.4 | 9.6 | | | | |
| 2-JMS099.30 | 7/19/2011 | S | 1 | 30 | 7.7 | 7.1 | | | | 0.5 |
| 2-JMS099.30 | 7/19/2011 | M | 2 | 29.9 | 7.6 | 6.6 | | | | |
| 2-JMS099.30 | 7/19/2011 | M | 3 | 29.8 | 7.6 | 6.3 | | | | |
| 2-JMS099.30 | 7/19/2011 | M | 4 | 29.7 | 7.5 | 6.1 | | | | |
| 2-JMS099.30 | 7/19/2011 | M | 5 | 29.6 | 7.5 | 5.8 | | | | |
| 2-JMS099.30 | 7/19/2011 | M | 6 | 29.6 | 7.5 | 5.7 | | | | |
| 2-JMS099.30 | 7/19/2011 | M | 7 | 29.6 | 7.5 | 5.8 | | | | |
| 2-JMS099.30 | 7/19/2011 | M | 8 | 29.6 | 7.5 | 5.9 | | | | |
| 2-JMS099.30 | 7/19/2011 | M | 9 | 29.6 | 7.5 | 5.9 | | | | |
| 2-JMS099.30 | 7/19/2011 | M | 10 | 29.6 | 7.5 | 5.9 | | | | |
| 2-JMS099.30 | 7/19/2011 | B | 11 | 29.6 | 7.5 | 5.7 | | | | |
| 2-JMS099.30 | 8/2/2011 | S | 1 | 32.8 | 7.6 | 5.7 | | | | 0.9 |
| 2-JMS099.30 | 8/2/2011 | M | 2 | 32.5 | 7.5 | 5.4 | | | | |
| 2-JMS099.30 | 8/2/2011 | M | 3 | 32.3 | 7.5 | 5.2 | | | | |
| 2-JMS099.30 | 8/2/2011 | M | 4 | 32.2 | 7.5 | 4.8 | | | | |
| 2-JMS099.30 | 8/2/2011 | M | 5 | 32.1 | 7.5 | 4.7 | | | | |
| 2-JMS099.30 | 8/2/2011 | M | 6 | 32.1 | 7.5 | 4.7 | | | | |
| 2-JMS099.30 | 8/2/2011 | M | 7 | 32.1 | 7.5 | 4.7 | | | | |
| 2-JMS099.30 | 8/2/2011 | M | 8 | 32.1 | 7.5 | 4.7 | | | | |
| 2-JMS099.30 | 8/2/2011 | B | 9 | 32 | 7.5 | 4.5 | | | | |
| 2-JMS099.30 | 9/22/2011 | S | 1 | 23.1 | 7.7 | 7.9 | | | | 1.2 |
| 2-JMS099.30 | 9/22/2011 | M | 2 | 22.9 | 7.7 | 7.9 | | | | |
| 2-JMS099.30 | 9/22/2011 | M | 3 | 22.8 | 7.7 | 7.8 | | | | |
| 2-JMS099.30 | 9/22/2011 | M | 4 | 22.5 | 7.7 | 7.7 | | | | |
| 2-JMS099.30 | 9/22/2011 | M | 5 | 22.4 | 7.6 | 7.7 | | | | |
| 2-JMS099.30 | 9/22/2011 | M | 6 | 22.3 | 7.6 | 7.6 | | | | |
| 2-JMS099.30 | 9/22/2011 | M | 7 | 22.3 | 7.6 | 7.6 | | | | |
| 2-JMS099.30 | 9/22/2011 | M | 8 | 22.3 | 7.6 | 7.6 | | | | |
| 2-JMS099.30 | 9/22/2011 | M | 9 | 22.3 | 7.6 | 7.5 | | | | |
| 2-JMS099.30 | 9/22/2011 | M | 10 | 22.3 | 7.6 | 7.5 | | | | |
| 2-JMS099.30 | 9/22/2011 | B | 11 | 22.3 | 7.6 | 7.5 | | | | |
| 2-JMS099.30 | 10/4/2011 | S | 1 | 21.3 | 7.6 | 7.2 | | | | 1.2 |
| 2-JMS099.30 | 10/4/2011 | M | 2 | 21.3 | 7.6 | 7.2 | | | | |
| 2-JMS099.30 | 10/4/2011 | M | 3 | 21.3 | 7.6 | 7.2 | | | | |
| 2-JMS099.30 | 10/4/2011 | M | 4 | 21.3 | 7.6 | 7.2 | | | | |
| 2-JMS099.30 | 10/4/2011 | M | 5 | 21.3 | 7.6 | 7.2 | | | | |
| 2-JMS099.30 | 10/4/2011 | M | 6 | 21.3 | 7.6 | 7.1 | | | | |
| 2-JMS099.30 | 10/4/2011 | M | 7 | 21.3 | 7.6 | 7.2 | | | | |
| 2-JMS099.30 | 10/4/2011 | M | 8 | 21.2 | 7.6 | 7.2 | | | | |
| 2-JMS099.30 | 10/4/2011 | M | 9 | 21.2 | 7.6 | 7.2 | | | | |
| 2-JMS099.30 | 10/4/2011 | B | 10 | 21.2 | 7.6 | 7.2 | | | | |
| 2-JMS099.30 | 11/1/2011 | S | 1 | 12.8 | 7.6 | 10.6 | | | | 1.1 |
| 2-JMS099.30 | 11/1/2011 | M | 2 | 12.7 | 7.6 | 10.6 | | | | |

| Station ID | Collection Date | Depth Desc | Depth | Temp Celcius | Field Ph | Do Probe | Do Winkler | Fdt Do Optical | Salinity | Secchi Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-JMS099.30 | 11/1/2011 | M | 3 | 12.7 | 7.6 | 10.6 | | | | |
| 2-JMS099.30 | 11/1/2011 | M | 4 | 12.6 | 7.5 | 10.6 | | | | |
| 2-JMS099.30 | 11/1/2011 | M | 5 | 12.5 | 7.5 | 10.6 | | | | |
| 2-JMS099.30 | 11/1/2011 | M | 6 | 12.5 | 7.5 | 10.7 | | | | |
| 2-JMS099.30 | 11/1/2011 | M | 7 | 12.5 | 7.5 | 10.7 | | | | |
| 2-JMS099.30 | 11/1/2011 | M | 8 | 12.5 | 7.5 | 10.7 | | | | |
| 2-JMS099.30 | 11/1/2011 | B | 9 | 12.5 | 7.5 | 10.7 | | | | |
| **90th Percentile** | | | | **29.3** | **7.9** | | | | | |
| **10th Percentile** | | | | **5.9** | **7.1** | | | | | |

| | | | | | 00900 | |
|---|---|---|---|---|---|---|
| | | | | | HARDNESS, TOTAL (MG/L AS CACO3) | |
| Sta Id | Collection Date Time | Depth Desc | Depth | Container Id Desc | Value | Com Code |
| 2-JMS099.30 | 06/18/1992 16:50 | S | 0.3 | R | 68 | |
| | 07/20/1992 15:30 | S | 0.3 | R | 82 | |
| | 09/01/1992 14:35 | S | 0.3 | R | 88 | |
| | 11/17/1992 14:48 | S | 0.3 | R | 62 | |
| | 12/15/1992 15:25 | S | 0.3 | R | 33 | |
| | 01/14/1993 14:50 | S | 0.3 | R | 46 | |
| | 02/09/1993 14:15 | S | 0.3 | R | 58 | |
| | 06/02/1993 13:30 | S | 0.3 | R | 0 | |
| | 08/18/1993 14:10 | S | 0.3 | R | 70 | |
| | 09/20/1993 14:15 | S | 0.3 | R | 98 | |
| | 10/05/1993 14:20 | S | 0.3 | R | 96 | |
| | 11/17/1993 14:00 | S | 0.3 | R | 94 | |
| | 12/02/1993 15:05 | S | 0.3 | R | 56 | |
| | 02/17/1994 15:35 | S | 1 | R | 42 | |
| | 03/21/1994 14:55 | B | 10 | R | 54 | |
| | | S | 1 | R | 54 | |
| | 04/14/1994 15:20 | S | 1 | R | 53 | |
| | 05/23/1994 16:05 | S | 1 | R | 68 | |
| | 06/09/1994 15:15 | S | 1 | R | 72 | |
| | 09/08/1994 15:00 | S | 1 | R | 75 | |
| | 10/17/1994 15:45 | S | 1 | R | 87 | |
| | 11/30/1994 15:15 | S | 1 | R | 75 | |
| | 12/06/1994 15:55 | S | 1 | R | 75 | |
| | 01/25/1995 15:05 | S | 1 | R | 55 | |
| | 02/27/1995 15:05 | S | 1 | R | 60 | |
| | 03/23/1995 15:50 | S | 1 | R | 58 | |
| | 04/18/1995 15:30 | S | 1 | R | 67 | |
| | 05/23/1995 15:10 | S | 1 | R | 45 | |
| | 06/20/1995 15:40 | S | 1 | R | 59 | |
| | 07/18/1995 15:25 | S | 1 | R | 66 | |
| | 08/23/1995 16:00 | S | 1 | R | 90 | |
| | 09/21/1995 14:45 | S | 1 | R | 115 | |
| | 10/19/1995 15:25 | S | 1 | R | 74 | |
| | 11/20/1995 15:35 | S | 1 | R | 73 | |
| | 12/14/1995 16:00 | S | 1 | R | 48 | |
| | 01/29/1996 15:30 | S | 1 | R | 28 | |
| | 02/20/1996 15:10 | S | 1 | R | 56 | |
| | 03/25/1996 15:10 | S | 1 | R | 60 | |
| | 04/29/1996 11:20 | S | 1 | R | 61 | |
| | 05/15/1996 14:35 | S | 1 | R | 56 | |
| | 06/18/1996 14:50 | S | 1 | R | 50 | |
| | 07/23/1996 15:35 | S | 1 | R | 70 | |
| | 08/20/1996 14:50 | S | 1 | R | 89 | |
| | 09/24/1996 14:55 | S | 1 | R | 64 | |
| | 10/22/1996 14:30 | S | 1 | R | 51 | |
| | 11/19/1996 15:15 | S | 1 | R | 61 | |
| | 12/10/1996 15:25 | S | 1 | R | 41 | |
| | 02/18/1997 15:50 | S | 1 | R | 43.3 | |
| | 03/18/1997 15:20 | S | 1 | R | 54 | |
| | 04/22/1997 15:25 | S | 1 | R | 79.9 | |
| | 05/28/1997 16:00 | S | 1 | R | 62.2 | |

| | | | | | 00900 | |
|---|---|---|---|---|---|---|
| | | | | | HARDNESS, TOTAL (MG/L AS CACO3) | |
| Sta Id | Collection Date Time | Depth Desc | Depth | Container Id Desc | Value | Com Code |
| | 06/24/1997 15:30 | S | 1 | R | 66.1 | |
| | 07/15/1997 15:30 | S | 1 | R | 79.4 | |
| | 08/19/1997 15:10 | S | 1 | R | 62.6 | |
| | 09/23/1997 15:05 | S | 1 | R | 75.7 | |
| | 10/21/1997 15:00 | S | 1 | R | 79.1 | |
| | 11/18/1997 15:15 | S | 1 | R | 68.3 | |
| | 12/10/1997 15:45 | S | 1 | R | 74.3 | |
| | 01/21/1998 15:45 | S | 1 | R | 46.8 | |
| | 02/18/1998 15:00 | S | 1 | R | 40.8 | |
| | 03/17/1998 15:30 | S | 1 | R | 44.1 | |
| | 04/21/1998 15:20 | S | 1 | R | 35.1 | |
| | 05/19/1998 15:25 | S | 1 | R | 47.1 | |
| | 06/23/1998 16:05 | S | 1 | R | 64.4 | |
| | 07/21/1998 15:15 | S | 1 | R | 69.6 | |
| | 08/18/1998 15:25 | S | 1 | R | 77.5 | |
| | 09/22/1998 17:30 | S | 1 | R | 89.3 | |
| | 10/20/1998 16:30 | S | 1 | R | 126 | |
| | 11/18/1998 15:15 | S | 1 | R | 102 | |
| | 12/15/1998 15:30 | S | 1 | R | 90 | |
| | 01/19/1999 15:20 | S | 1 | R | 76 | |
| | 02/23/1999 15:10 | S | 1 | R | 60 | |
| | 03/23/1999 15:30 | S | 1 | R | 68 | |
| | 04/20/1999 16:35 | S | 1 | R | 84 | |
| | 05/20/1999 15:20 | S | 1 | R | 60 | |
| | 06/22/1999 15:15 | S | 1 | R | 80.1 | |
| | 07/20/1999 16:15 | S | 1 | R | 96 | |
| | 08/17/1999 16:00 | S | 1 | R | 109 | |
| | 09/21/1999 16:20 | S | 1 | R | 40.9 | |
| | 10/28/1999 15:10 | S | 1 | R | 74.6 | |
| | 11/18/1999 15:27 | S | 1 | R | 62.7 | |
| | 12/21/1999 15:05 | S | 1 | R | 54.1 | |
| | 01/18/2000 16:15 | S | 1 | S1 | 55.8 | |
| | 02/23/2000 14:15 | S | 1 | R | 54 | |
| | 03/28/2000 15:30 | S | 1 | S1 | 43 | |
| | 04/24/2000 15:55 | S | 1 | R | 40 | |
| | 05/23/2000 17:20 | S | 1 | R | 57 | |
| | 06/20/2000 16:05 | S | 1 | R | 65.6 | |
| | 07/18/2000 16:35 | S | 1 | R | 76 | |
| | 08/22/2000 15:20 | S | 1 | R | 76.4 | |
| | 09/26/2000 16:20 | S | 1 | R | 65.1 | |
| | 10/24/2000 15:20 | S | 1 | R | 86.9 | |
| | 11/28/2000 16:50 | S | 1 | R | 123 | |
| | 01/23/2001 14:00 | S | 1 | R | 47.8 | |
| | 02/20/2001 13:20 | S | 1 | R | 58.9 | |
| | 03/27/2001 15:00 | S | 1 | R | 25.1 | |
| | 04/24/2001 13:50 | S | 1 | R | 47.2 | |
| | 06/19/2001 14:30 | S | 1 | R | 30.9 | |
| | 07/24/2001 14:40 | S | 1 | R | 77.8 | |
| | 08/21/2001 15:20 | S | 1 | R | 62.6 | |
| | 09/18/2001 16:20 | S | 1 | R | 28.3 | |
| | 10/16/2001 15:00 | S | 1 | S1 | 200.6 | |

| | | | | | 00900 | |
|---|---|---|---|---|---|---|
| | | | | | HARDNESS, TOTAL (MG/L AS CACO3) | |
| Sta Id | Collection Date Time | Depth Desc | Depth | Container Id Desc | Value | Com Code |
| | 11/27/2001 15:30 | S | 1 | R | 132 | |
| | 12/12/2001 14:50 | S | 1 | R | 137 | |
| | 01/22/2002 15:25 | S | 1 | R | 78.8 | |
| | 02/19/2002 15:15 | S | 1 | R | 54 | |
| | 03/19/2002 15:30 | S | 1 | R | 37.3 | |
| | 04/16/2002 15:40 | S | 1 | R | 57.9 | |
| | 05/30/2002 16:20 | S | 1 | R | 68 | |
| | 06/25/2002 15:20 | S | 1 | R | 94.2 | |
| | 07/23/2002 15:00 | S | 1 | R | 124 | |
| | 08/13/2002 15:40 | S | 1 | R | 151 | |
| | 09/24/2002 15:40 | S | 1 | R | 95.5 | |
| | 10/22/2002 15:50 | S | 1 | R | 121 | |
| | 11/19/2002 16:10 | S | 1 | R | 30.5 | |
| | 12/10/2002 15:15 | S | 1 | R | 34.8 | |
| | 01/21/2003 15:45 | S | 1 | R | 67.9 | |
| | 02/25/2003 11:13 | S | 1 | R | 51.3 | |
| | 03/18/2003 15:40 | S | 1 | R | 48.8 | |
| | 04/15/2003 17:00 | S | 1 | R | 47 | |
| | 05/27/2003 14:19 | S | 1 | R | 43.8 | |
| | 06/24/2003 14:50 | S | 1 | R | 58.7 | |
| | 07/15/2003 15:00 | S | 1 | R | 48.8 | |
| | 08/26/2003 16:00 | S | 1 | R | 52.8 | |
| | 09/24/2003 15:37 | S | 1 | R | 24.9 | |
| | 10/28/2003 15:30 | S | 1 | R | 72.8 | |
| | 11/18/2003 15:00 | S | 1 | R | 50 | |
| | 12/16/2003 15:00 | S | 1 | R | 42 | |
| | 02/25/2004 15:00 | S | 1 | R | 56.4 | |
| | 03/23/2004 15:20 | S | 1 | R | 62.9 | |
| | 04/20/2004 14:40 | S | 1 | R | 51 | |
| | 05/18/2004 15:00 | S | 1 | R | 60 | |
| | 06/15/2004 15:00 | S | 1 | R | 51 | |
| | 07/20/2004 14:45 | S | 1 | R | 66.9 | |
| | 08/17/2004 15:00 | S | 1 | R | 45.5 | |
| | 09/21/2004 14:45 | S | 1 | R | 47.8 | |
| | 10/19/2004 14:20 | S | 1 | R | 36 | |
| | 11/16/2004 14:45 | S | 1 | R | 43 | |
| | 12/14/2004 15:25 | S | 1 | R | 57 | |
| | 01/26/2005 15:00 | S | 1 | R | 56 | |
| | 02/15/2005 14:40 | S | 1 | R | 72 | |
| | 03/22/2005 15:15 | S | 1 | R | 60 | |
| | 04/19/2005 15:40 | S | 1 | R | 54.7 | |
| | 05/24/2005 14:45 | S | 1 | R | 46 | |
| | 06/21/2005 14:50 | S | 1 | R | 74 | |
| | 07/19/2005 15:00 | S | 1 | R | 76 | |
| | 08/23/2005 15:30 | S | 1 | R | 74 | |
| | 09/20/2005 15:00 | S | 1 | R | 114 | |
| | 10/18/2005 15:20 | S | 1 | R | 56 | |
| | 11/15/2005 14:30 | S | 1 | R | 94 | |
| | 12/21/2005 15:00 | S | 1 | R | 53 | |
| | 01/17/2006 14:45 | S | 1 | S1 | 69 | |
| | 02/21/2006 15:10 | S | 1 | R | 59 | |

| | | | | | 00900 | |
|---|---|---|---|---|---|---|
| | | | | | **HARDNESS, TOTAL (MG/L AS CACO3)** | |
| **Sta Id** | **Collection Date Time** | **Depth Desc** | **Depth** | **Container Id Desc** | **Value** | **Com Code** |
| | 03/20/2006 15:15 | S | 1 | R | 72 | |
| | 04/26/2006 15:00 | S | 1 | R | 52 | |
| | 05/15/2006 15:00 | S | 1 | R | 62 | |
| | 07/24/2006 14:25 | S | 1 | R | 78 | |
| | 08/22/2006 15:00 | S | 1 | R | 88 | |
| | 10/30/2006 15:10 | S | 1 | R | 52 | |
| | 11/15/2006 14:30 | S | 1 | R | 38 | |
| | 01/24/2007 14:45 | S | 1 | R | 58 | |
| **Average** | | | | | **66** | |

# 2010 Fact Sheets for 303(d) Waters

**RIVER BASIN:** James River Basin

**HYDROLOGIC UNIT:** 02080206

**STREAM NAME:** **James River**

**TMDL ID:** **G01E-01-BAC**

**2010 IMPAIRED AREA ID:** CB-JMSTFU

**ASSESSMENT CATEGORY:** 5A

**TMDL DUE DATE:** 2010

**IMPAIRED SIZE:** 6.2581 - Sq. Mi.

**Watershed:** VAP-G01E

**INITIAL LISTING:** 1996

**UPSTREAM LIMIT:** Fall Line (Mayos Bridge)

**DOWNSTREAM LIMIT:** Appomattox River

Estuarine James River from the fall line at Mayos Bridge downstream to the Appomattox River.

**CLEAN WATER ACT GOAL AND USE SUPPORT:**

Recreation Use - Not Supporting

**IMPAIRMENT:** E.coli

The James River from the fall line to the Appomattox River has been assessed as not supporting of the Recreation use support goal based on the results of a summer special study in the fall zone. The special study was designed to monitor the effects of summertime rain and combined sewer overflow (CSO) events on water quality in the James River and to monitor the effects of Richmond's CSO abatement efforts.

The segment has been included on the Impaired Waters list for fecal coliform since 1996. During the 2004 and 2006 cycles, the bacteria standard changed to E.coli for those stations with enough data. Some of the areas in this segment had converted to the E.coli standard, for others the fecal coliform standard was still in effect. During the 2008 cycle, the impairment was converted solely to E. coli. The TMDL for bacteria is due in 2010.

Bacteria impairment is noted at the following stations during the 2010 cycle:
2-JMS110.30
2-JMS104.16
2-JMS099.30

Although station 2-JMS087.01 is currently passing (5/50), the downstream extent will remain the same for this cycle due to the historical impairment and the marginal passing rate.

Farrar Gut was mistakenly combined with the mainstem in previous assessments. The stream is a separate waterbody and should not be included in the bacterial impairment, which only included the "estuarine James River".

**IMPAIRMENT SOURCE:** NPS - Urban, CSO

The source of the impairment in this section of the river is believed to be urban runoff from the tributary drainage basin and from combined sewer overflow events from the City of Richmond's combined sewer system.

The City is currently undertaking CSO abatement efforts. It is recommended that the ongoing CSO special study be continued to gauge the effects of CSO abatement efforts on water quality in this segment.

**RECOMMENDATION:** Problem Characterization

# 2010 Fact Sheets for 303(d) Waters

**RIVER BASIN:** James River Basin

**HYDROLOGIC UNIT:** 02080206

**STREAM NAME:** **James River**

**TMDL ID:** **G01E-02-CHLA**

**2010 IMPAIRED AREA ID:** CB-JMSTFU

**ASSESSMENT CATEGORY:** 5A

**TMDL DUE DATE:** 2010

**IMPAIRED SIZE:** 5.5117 - Sq. Mi.

**Watershed:** VAP-G01E

**INITIAL LISTING:** 2008

**UPSTREAM LIMIT:** Fall Line (Mayos Bridge)

**DOWNSTREAM LIMIT:** Appomattox River

Mainstem James River from the fall line at Mayos Bridge downstream to the JMSTFu/JMSTFl boundary at the Appomattox River.

**CLEAN WATER ACT GOAL AND USE SUPPORT:**

Aquatic Life Use - Not Supporting, Open Water Subuse - Not Supporting

**IMPAIRMENT:** Chlorophyll

The James River from the Appomattox River to the Chickahominy River was originally listed on the 1998 list as fully supporting but threatened of the Aquatic Life Use goal based on chlorophyll_a exceedances. During the 1998 cycle, EPA extended the segment upstream to the fall line and downgraded the river to not supporting the Aquatic Life Use, citing nutrient concerns.

In previous cycles, the mainstem James River had acceptable dissolved oxygen levels. In addition the entire tidal freshwater portion (fall line to just above the Chickahominy River) has good benthic community based on the results from the Chesapeake Bay Benthic Index of Biological Community; therefore the James River from the fall line to the oligohaline boundary was considered impaired solely for Nutrients/Eutrophication Biological Indicators (EPA Overlist).

A special site-specific chlorophyll standard for the mainstem James River was adopted during the 2008 cycle. The upper tidal freshwater segment exceeds both the spring and summer seasonal means.

Farrar Gut was mistakenly combined with the mainstem in previous assessments. The stream is a separate waterbody and should not be included in the chlorophyll a impairment, which only includes the mainstem James River.

**IMPAIRMENT SOURCE:** Point sources, Nonpoint Sources

The James River Tributary Strategy was developed to bring the river into attainment.

**RECOMMENDATION:** Problem Characterization

# 2010 Fact Sheets for 303(d) Waters

**RIVER BASIN:** James River Basin

**HYDROLOGIC UNIT:** 02080206

**STREAM NAME:** **James River and Various Tributaries**

**TMDL ID:** **G01E-03-PCB**

**2010 IMPAIRED AREA ID:** CB-JMSTFU

**ASSESSMENT CATEGORY:** 5A

**TMDL DUE DATE:** 2014

**IMPAIRED SIZE:** ~325 - Stream mile

**Watershed:** VAP-G01E

**INITIAL LISTING:** 2002

**UPSTREAM LIMIT:** Fall line

**DOWNSTREAM LIMIT:** Hampton Roads Bridge Tunnel

Estuarine James River from the fall line to the Hampton Roads Bridge Tunnel, including several tributaries listed below.

**CLEAN WATER ACT GOAL AND USE SUPPORT:**

Fish Consumption Use - Not Supporting

**IMPAIRMENT:** Fish Tissue - PCBs, VDH Fish Consumption Restriction

During the 2002 cycle, the James River from the Fall line to Queens Creek was considered not supporting of the Fish Consumption Use due to PCBs in multiple fish species at multiple DEQ monitoring locations.

During the 2004 cycle, a VDH Fish Consumption Restriction was issued from the fall line to Flowerdew Hundred and the segment was adjusted slightly to match the Restriction. In addition, in the 2004 cycle, the Chickahominy River from Walkers Dam to Diascund Creek was assessed as not supporting the Fish Consumption Use because the DEQ screening value for PCBs was exceeded in 3 species during sampling in 2001.

During the 2006 cycle, the VDH restriction was extended on 12/13/2004 to extend from the I-95 bridge downstream to the Hampton Roads Bridge Tunnel and include the tidal portions of the following tributaries:

Appomattox River up to Lake Chesdin Dam
Bailey Creek up to Route 630
Bailey Bay
Chickahominy River up to Walkers Dam
Skiffes Creek up to Skiffes Creek Dam
Pagan River and its tributary Jones Creek
Chuckatuck Creek
Nansemond River and its tributaries Bennett Creek and Star Creek
Hampton River
Willoughby Bay and the Elizabeth R. system (Western, Eastern, and Southern Branches and Lafayette R.) and tributaries St. Julian Creek, Deep Creek, and Broad Creek

The advisory was modified again on 10/10/2006 to add Poythress Run.

The impairments were combined. The TMDL for the lower extended portion is due in 2018.

Farrar Gut was mistakenly combined with the mainstem in previous assessments. The stream is a separate waterbody and is not included in the VDH Fish Consumption Advisory.

**IMPAIRMENT SOURCE:** Unknown

The source of the PCBs is considered unknown.

# 2010 Fact Sheets for 303(d) Waters

**RIVER BASIN:** James River Basin

**HYDROLOGIC UNIT:** 02080206

**STREAM NAME:** **James River Tidal Freshwater (Upper) Estuary**

**TMDL ID:** **JMSTFU-DO-BAY**

**2010 IMPAIRED AREA ID:** CB-JMSTFU

**ASSESSMENT CATEGORY:** 5A

**TMDL DUE DATE:** 2010

**IMPAIRED SIZE:** 6.5749 - Sq. Mi.

**Watershed:** VAP-G01E

**INITIAL LISTING:** 1998

**UPSTREAM LIMIT:** Fall line

**DOWNSTREAM LIMIT:** Tidal Freshwater/Oligohaline Boundary

The James River Tidal Freshwater Upper estuary, which extends from the fall line to approximately the Appomattox River, including tributaries.

**CLEAN WATER ACT GOAL AND USE SUPPORT:**

Aquatic Life Use - Not Supporting

**IMPAIRMENT:** Dissolved Oxygen

The mainstem James River from the Appomattox River to the Chickahominy River was originally listed on the 1998 list as fully supporting but threatened of the Aquatic Life Use goal based on chlorophyll_a exceedances. During the 1998 cycle, EPA extended the segment upstream to the fall line and downgraded the river to not supporting the Aquatic Life Use, citing nutrient concerns.

In previous cycles, the mainstem James River had acceptable dissolved oxygen levels. In addition the entire tidal freshwater portion (fall line to just above the Chickahominy River) has good benthic community based on the results from the Chesapeake Bay Benthic Index of Biological Community; therefore the James River from the fall line to the oligohaline boundary was considered impaired solely for Nutrients/Eutrophication Biological Indicators (EPA Overlist).

The CB water quality standards were implemented during the 2006 cycle. The 30-day dissolved oxygen criteria was met during the 2006 and 2008 cycles; however, during the 2010 cycle, the segment failed the summer 30-day Open Water dissolved oxygen criteria. The rest-of-year standard was met.

**IMPAIRMENT SOURCE:** Nonpoint Source, Point Source

The tributary strategy for the James River assigned sources and allocations.

**RECOMMENDATION:** Problem Characterization

# 2010 Fact Sheets for 303(d) Waters

**RIVER BASIN:** James River Basin

**HYDROLOGIC UNIT:** 02080206

**STREAM NAME:** **James River Tidal Freshwater (Upper) Estuary**

**TMDL ID:** **JMSTFU-SAV-BAY**

**2010 IMPAIRED AREA ID:** CB-JMSTFU

**ASSESSMENT CATEGORY:** 5A

**TMDL DUE DATE:** 2010

**IMPAIRED SIZE:** 6.5998 - Sq. Mi.

**Watershed:** VAP-G01E

**INITIAL LISTING:** 1998

**UPSTREAM LIMIT:** Fall line

**DOWNSTREAM LIMIT:** Tidal Freshwater/Oligohaline Boundary

The James River Tidal Freshwater Upper estuary, which extends from the fall line to approximately the Appomattox River, including tributaries.

**CLEAN WATER ACT GOAL AND USE SUPPORT:**

Aquatic Life Use - Not Supporting, Shallow Water Use - Not Supporting

**IMPAIRMENT:** Aquatic Macrophytes

The mainstem James River from the Appomattox River to the Chickahominy River was originally listed on the 1998 list as fully supporting but threatened of the Aquatic Life Use goal based on chlorophyll_a exceedances. During the 1998 cycle, EPA extended the segment upstream to the fall line and downgraded the river to not supporting the Aquatic Life Use, citing nutrient concerns.

In previous cycles, the mainstem James River had acceptable dissolved oxygen levels. In addition the entire tidal freshwater portion (fall line to just above the Chickahominy River) has good benthic community based on the results from the Chesapeake Bay Benthic Index of Biological Community; therefore the James River from the fall line to the oligohaline boundary was considered impaired solely for Nutrients/Eutrophication Biological Indicators (EPA Overlist).

During the 2006 cycle, the CB water quality standards were implemented. The Upper Tidal Freshwater James River from the fall line to the Appomattox fails the Shallow Water Use SAV criteria.

**IMPAIRMENT SOURCE:** Nonpoint Source, Point Source

The tributary strategy for the James River assigned sources and allocations.

**RECOMMENDATION:** Problem Characterization

**Attachment 4**

Effluent Characterization

# DMR DATA

Facility Name: Virginia Power-Chesterfield
Permit No:VA0004146

Outfall 001

| | FLOW (MGD) | | TEMP (ºF) | HEAT (BTU/hr) | TP (mg/L) |
|---|---|---|---|---|---|
| Due Date | Quant Avg | Quanti Max | Max | Quanti Max | Conc Max |
| 9/10/2008 | 208 | 212 | 111 | 7.7 | 0.1 |
| 10/10/2008 | 205 | 212 | 100 | 7.7 | 0.07 |
| 11/10/2008 | 160 | 212 | 103 | 7.8 | 0.07 |
| 12/10/2008 | 189 | 212 | 86 | 7.8 | 0.07 |
| 1/10/2009 | 180 | 212 | 74 | 7.8 | 0.06 |
| 2/10/2009 | 211 | 212 | 67 | 7.8 | 0.05 |
| 3/10/2009 | 179 | 212 | 77 | 7.8 | <QL |
| 4/10/2009 | 142 | 159 | 87 | 7.6 | <QL |
| 5/10/2009 | 104 | 159 | 93 | 7 | 0.06 |
| 6/10/2009 | 134 | 159 | 101 | 7.6 | 0.06 |
| 7/10/2009 | 193 | 212 | 114 | 7.7 | 0.05 |
| 8/10/2009 | 203 | 212 | 108 | 7.8 | 0.06 |
| 9/10/2009 | 205 | 212 | 118 | 7.8 | 0.07 |
| 10/10/2009 | 210 | 212 | 109 | 7.9 | 0.06 |
| 11/10/2009 | 182 | 212 | 98 | 7.8 | 0.06 |
| 12/10/2009 | 126 | 159 | 73 | 4.1 | <QL |
| 1/10/2010 | 179 | 212 | 87 | 7.8 | 0.06 |
| 2/10/2010 | 200 | 212 | 82 | 7.9 | <QL |
| 3/10/2010 | 207 | 212 | 68 | 8.1 | <QL |
| 4/10/2010 | 93 | 159 | 77 | 5.5 | <QL |
| 5/10/2010 | 145 | 159 | 89 | 4 | <QL |
| 6/10/2010 | 141 | 212 | 100 | 7.9 | <QL |
| 7/10/2010 | 187 | 212 | 112 | 7.8 | <QL |
| 8/10/2010 | 205 | 212 | 111 | 7.7 | 0.06 |
| 9/10/2010 | 209 | 212 | 111 | 7.8 | 0.32 |
| 10/10/2010 | 207 | 212 | 107 | 7.7 | <QL |
| 11/10/2010 | 134 | 212 | 127 | 7.4 | <QL |
| 12/10/2010 | 118 | 212 | 78 | 7.3 | <QL |
| 1/10/2011 | 210 | 212 | 68 | 7.2 | <QL |
| 2/10/2011 | 206 | 212 | 61 | 7.7 | <QL |
| 3/10/2011 | 212 | 212 | 82 | 7.6 | <QL |
| 4/10/2011 | 184 | 212 | 96 | 7.4 | <QL |
| 5/10/2011 | 146 | 212 | 89 | 7.2 | <QL |
| 6/10/2011 | 141 | 212 | 100 | 7.6 | 0.009 |
| 7/10/2011 | 190 | 212 | 105 | 7.5 | 0.06 |
| 8/10/2011 | 204 | 212 | 114 | 7.1 | 0.1 |
| 9/10/2011 | 197 | 212 | 113 | 7.4 | 0.31 |
| 10/10/2011 | 168 | 212 | 104 | 7.5 | 0.09 |
| Average: | 176.6842 | 203.63 | 94.7368 | 7.38947 | 0.08805 |
| 90th Percentile: | 209.3 | 212 | 113.3 | 7.83 | 0.1 |
| 10th Percentile: | 131.6 | 159 | 71.5 | 7.07 | 0.05 |
| Max | 212 | 212 | 127 | 8.1 | 0.32 |

Outfall 002

| | FLOW (MGD) | | TEMP (ºF) | HEAT (BTU/h | TP (mg/L) |
|---|---|---|---|---|---|
| Due Date | Quant Avg | Quanti Max | Max | Quanti Max | Conc Max |
| 9/10/2008 | 73 | 89 | 127 | 5.29 | 0.11 |
| 10/10/2008 | 66 | 89 | 123 | 5.4 | 0.07 |
| 11/10/2008 | 56 | 89 | 103 | 5.04 | 0.08 |
| 12/10/2008 | 86 | 89 | 126 | 5.19 | 0.07 |
| 1/10/2009 | 88 | 89 | 107 | 5.03 | <QL |
| 2/10/2009 | 82 | 89 | 94 | 5.02 | <QL |
| 3/10/2009 | 75 | 89 | 104 | 4.94 | <QL |
| 4/10/2009 | 89 | 89 | 100 | 4.94 | <QL |
| 5/10/2009 | 78 | 89 | 101 | 4.98 | 0.06 |
| 6/10/2009 | 86 | 89 | 103 | 5.01 | 0.06 |
| 7/10/2009 | 88 | 89 | 116 | 5.23 | <QL |
| 8/10/2009 | 83 | 89 | 117 | 5.19 | 0.06 |
| 9/10/2009 | 83 | 89 | 122 | 5.3 | 0.07 |
| 10/10/2009 | 54 | 89 | 120 | 5.18 | 0.06 |
| 11/10/2009 | 74 | 89 | 109 | 5.32 | 0.06 |
| 12/10/2009 | 76 | 89 | 92 | 5.03 | <QL |
| 1/10/2010 | 82 | 89 | 97 | 5.03 | 0.05 |
| 2/10/2010 | 78 | 89 | 122 | 5 | <QL |
| 3/10/2010 | 46 | 89 | 105 | 4.97 | 0.05 |
| 4/10/2010 | 39 | 45 | 117 | 5.34 | <QL |
| 5/10/2010 | 40 | 45 | 80 | 2.07 | <QL |
| 6/10/2010 | 45 | 89 | 129 | 5.18 | <QL |
| 7/10/2010 | 86 | 89 | 119 | 5.27 | <QL |
| 8/10/2010 | 89 | 89 | 121 | 5.25 | 0.05 |
| 9/10/2010 | 82 | 89 | 116 | 5.24 | 0.38 |
| 10/10/2010 | 51 | 89 | 114 | 5.15 | 0.05 |
| 11/10/2010 | 28 | 45 | 79 | 0 | <QL |
| 12/10/2010 | 46 | 89 | 79 | 4.81 | <QL |
| 1/10/2011 | 87 | 89 | 106 | 5.46 | <QL |
| 2/10/2011 | 85 | 89 | 83 | 5.2 | <QL |
| 3/10/2011 | 56 | 89 | 71 | 5.12 | <QL |
| 4/10/2011 | 12 | 45 | 69 | 2.07 | <QL |
| 5/10/2011 | 29 | 89 | 98 | 5.11 | <QL |
| 6/10/2011 | 50 | 89 | 110 | 5.15 | 0.09 |
| 7/10/2011 | 77 | 89 | 114 | 5.38 | 0.42 |
| 8/10/2011 | 75 | 89 | 121 | 5.35 | 0.07 |
| 9/10/2011 | 60 | 89 | 121 | 5.21 | 0.11 |
| 10/10/2011 | 52 | 89 | 90 | 2.03 | 0.06 |
| Average: | 66.632 | 84.368 | 105.92 | 4.7758 | 0.102 |
| 90th Percentile: | 87.3 | 89 | 122.3 | 5.343 | 0.137 |
| 10th Percentile: | 39.7 | 75.8 | 79.7 | 3.988 | 0.05 |
| Max | 89 | 89 | 129 | 5.46 | 0.42 |
| 90th Percentile (º Celsius): | | | 50.2 | | |

Outfall 003

| | FLOW (MGD) | | TEMP (ºF) | HEAT (BTU/hr) | TP (mg/L) |
|---|---|---|---|---|---|
| Due Date | Quant Avg | Quanti Max | Max | Quanti Max | Conc Max |
| 9/10/2008 | 755 | 757 | 125 | 5.18 | 0.1 |
| 10/10/2008 | 665 | 757 | 125 | 5.24 | 0.06 |
| 11/10/2008 | 587 | 700 | 111 | 4.51 | 0.09 |
| 12/10/2008 | 595 | 757 | 116 | 3.71 | 0.09 |
| 1/10/2009 | 729 | 757 | 117 | 5.17 | 0.07 |
| 2/10/2009 | 756 | 757 | 105 | 5.16 | <QL |
| 3/10/2009 | 757 | 757 | 108 | 5.09 | <QL |
| 4/10/2009 | 567 | 757 | 90 | 5.2 | <QL |
| 5/10/2009 | 745 | 757 | 126 | 5.21 | <QL |
| 6/10/2009 | 716 | 757 | 126 | 5.26 | 0.06 |
| 7/10/2009 | 729 | 757 | 128 | 5.33 | <QL |
| 8/10/2009 | 733 | 757 | 125 | 5.3 | 0.05 |
| 9/10/2009 | 749 | 757 | 125 | 5.33 | 0.07 |
| 10/10/2009 | 716 | 757 | 128 | 5.31 | 0.06 |
| 11/10/2009 | 648 | 757 | 120 | 5.23 | 0.08 |
| 12/10/2009 | 702 | 757 | 124 | 5.21 | <QL |
| 1/10/2010 | 733 | 757 | 125 | 5.15 | <QL |
| 2/10/2010 | 708 | 757 | 115 | 5.19 | <QL |
| 3/10/2010 | 652 | 757 | 118 | 5.14 | 0.05 |
| 4/10/2010 | 690 | 700 | 127 | 5.17 | <QL |
| 5/10/2010 | 656 | 700 | 123 | 5.22 | <QL |
| 6/10/2010 | 643 | 699 | 127 | 5.2 | <QL |
| 7/10/2010 | 750 | 757 | 131 | 5.27 | <QL |
| 8/10/2010 | 748 | 757 | 129 | 5.31 | 0.06 |
| 9/10/2010 | 737 | 737 | 123 | 5.31 | 0.08 |
| 10/10/2010 | 511 | 699 | 121 | 5.25 | <QL |
| 11/10/2010 | 267 | 325 | 104 | 2.11 | <QL |
| 12/10/2010 | 104 | 403 | 103 | 1.63 | <QL |
| 1/10/2011 | 429 | 757 | 104 | 5.06 | <QL |
| 2/10/2011 | 736 | 757 | 97 | 5.29 | <QL |
| 3/10/2011 | 533 | 547 | 112 | 5.16 | <QL |
| 4/10/2011 | 520 | 547 | 121 | 3.94 | <QL |
| 5/10/2011 | 510 | 757 | 113 | 3.92 | <QL |
| 6/10/2011 | 696 | 757 | 122 | 5.46 | 0.13 |
| 7/10/2011 | 743 | 757 | 128 | 5.52 | 0.06 |
| 8/10/2011 | 727 | 757 | 128 | 5.45 | 0.05 |
| 9/10/2011 | 637 | 652 | 128 | 4.82 | 0.07 |
| 10/10/2011 | 710 | 757 | 121 | 5.31 | 0.07 |
| Average: | 647.0789 | 714.42 | 118.921 | 4.92947 | 0.07222 |
| 90th Percentile: | 749.3 | 757 | 128 | 5.33 | 0.093 |
| 10th Percentile: | 511 | 620.5 | 104 | 3.934 | 0.05 |
| Max | 757 | 757 | 131 | 5.52 | 0.13 |
| 90th Percentile (º Celsius): | | | 53.3 | | |

Outfall 004

| | FLOW (MGD) | | pH (S.U.) | | DO (mg/L) | TPH (mg/L) | AMMONIA (mg/L) | | TSS (mg/L) | | TOC (mg/L) | TP (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Due Date | Quant Avg | Quanti Max | Min | Max | Conc Min | Conc Avg | Conc Avg | Conc Max | Conc Avg | Conc Max | Conc Max | Conc Max |
| 9/10/2008 | 9.41 | 11.21 | 7.5 | 7.5 | 5.8 | | 0.65 | 0.78 | 7.3 | 7.5 | 2.1 | <QL |
| 10/10/2008 | 9.97 | 13.17 | 7 | 7.1 | 6.3 | | 0.81 | 1.15 | 10.6 | 13.7 | 1.8 | 0.06 |
| 11/10/2008 | 7.73 | 8.81 | 6.8 | 7 | 7 | | 0.66 | 0.79 | 5.9 | 7.8 | 2 | <QL |
| 12/10/2008 | 7.71 | 8.56 | 7.6 | 7.7 | 8.8 | | 1.01 | 1.22 | 9.2 | 9.7 | 3.4 | <QL |
| 1/10/2009 | 9.61 | 13.89 | 7.5 | 7.6 | 11.5 | | 1.74 | 1.85 | 12.8 | 13.4 | 2.8 | 0.06 |
| 2/10/2009 | 9.92 | 11.33 | 7 | 7.1 | 10.7 | <QL | 1.9 | 2.28 | 6.4 | 7.3 | 1.2 | <QL |
| 3/10/2009 | 9.74 | 10.25 | 6.8 | 7.4 | 11.6 | | 2 | 2.76 | 4.8 | 5.3 | 2.2 | <QL |
| 4/10/2009 | 9.3 | 11.74 | 7.3 | 7.6 | 11.6 | | 0.95 | 1.44 | 9.6 | 10.8 | 1.4 | <QL |
| 5/10/2009 | 9.65 | 10.59 | 7.3 | 7.4 | 9.4 | | 0.29 | 0.35 | 6.3 | 7.4 | 1.1 | 0.08 |
| 6/10/2009 | 9.53 | 11.74 | 7.3 | 7.6 | 7.9 | | 0.2 | 0.29 | 7.2 | 7.6 | 3.1 | 0.11 |
| 7/10/2009 | 9.13 | 10.95 | 7.6 | 8 | 7.6 | | 0.06 | 0.17 | 6.5 | 7 | 2.3 | 0.09 |
| 8/10/2009 | 9.49 | 11.33 | 8.2 | 8.6 | 8.2 | | 0.13 | 0.17 | 6.9 | 7.6 | 2.6 | 0.09 |
| 9/10/2009 | 9.64 | 10.25 | 8.1 | 8.3 | 6.5 | | 0.1 | 0.13 | 5.2 | 5.5 | 2.2 | 0.07 |
| 10/10/2009 | 9.1 | 10.95 | 8 | 8.1 | 6.5 | | 0.17 | 0.25 | 7 | 7.7 | 5 | 0.08 |
| 11/10/2009 | 9.56 | 11.33 | 7.8 | 8 | 7.9 | | 0.16 | 0.2 | 10.3 | 10.4 | 3.1 | 0.08 |
| 12/10/2009 | 10.54 | 17.33 | 7.2 | 7.6 | 8.5 | | 0.27 | 0.29 | 9.3 | 9.5 | 0.6 | 0.09 |
| 1/10/2010 | 11.57 | 15.75 | 6.6 | 6.8 | 10 | | 0.4 | 0.46 | 6.3 | 7.1 | 1.1 | 0.42 |
| 2/10/2010 | 10.39 | 13.7 | 6.3 | 7.2 | 13 | <QL | 0.68 | 0.77 | 6.8 | 6.8 | 3.3 | <QL |
| 3/10/2010 | 10.74 | 13.74 | 6.8 | 7.1 | 12.5 | | 0.5 | 0.59 | 5.5 | 7.8 | 0.7 | <QL |
| 4/10/2010 | 9.76 | 14.36 | 7 | 7.5 | 11 | | 0.59 | 0.64 | 4.6 | 5.4 | 2.4 | 0.13 |
| 5/10/2010 | 9.15 | 10.25 | 7.1 | 7.2 | 8.7 | | 0.54 | 0.6 | 5.4 | 5.6 | 2 | 0.08 |
| 6/10/2010 | 9.26 | 11.33 | 7.7 | 7.9 | 8.2 | | 0.55 | 0.63 | 8.7 | 13.4 | 1.3 | <QL |
| 7/10/2010 | 10.05 | 10.95 | 6.6 | 6.9 | 7.1 | | 1.71 | 1.85 | 2.3 | 3 | 0.5 | <QL |
| 8/10/2010 | 9.84 | 10.25 | 8 | 8.1 | 7.3 | | 0.83 | 1.04 | 4.3 | 4.7 | 1.9 | 0.1 |
| 9/10/2010 | 9.67 | 11.33 | 7.69 | 8.01 | 6 | | 0.82 | 1.17 | 2.8 | 3.1 | 2.8 | 0.16 |
| 10/10/2010 | 7.41 | 15.23 | 7.7 | 8.3 | 6 | | 0.33 | 0.93 | 3.6 | 3.8 | 3.5 | 0.09 |
| 11/10/2010 | 6.03 | 9.93 | 7.6 | 7.9 | 8.9 | | 0.43 | 0.76 | 7.9 | 12 | 2.4 | 0.08 |
| 12/10/2010 | 4.79 | 6.28 | 7.1 | 7.4 | 10.5 | | 0.17 | 0.23 | 7.7 | 7.8 | 3 | <QL |
| 1/10/2011 | 8.74 | 13.16 | 7.2 | 7.4 | 11.4 | | 0.15 | 0.8 | 9.6 | 11.6 | 3.4 | <QL |
| 2/10/2011 | 15.3 | 19.88 | 7.1 | 7.6 | 12.7 | <QL | 0.72 | 1 | 7.4 | 7.8 | 1.9 | 0.07 |
| 3/10/2011 | 10.55 | 17.3 | 7 | 7.1 | 11.3 | | 1.87 | 2.19 | 8.1 | 8.3 | 2.9 | <QL |
| 4/10/2011 | 8.47 | 12.65 | 7.6 | 7.6 | 10.2 | | 1.72 | 2.06 | 20.1 | 35.6 | 3.5 | <QL |
| 5/10/2011 | 8.55 | 14.36 | 7.3 | 7.5 | 10.9 | | 2.04 | 2.29 | 13.8 | 20.6 | 2.8 | <QL |
| 6/10/2011 | 10.47 | 14.27 | 7.5 | 7.5 | 7.4 | | 1.6 | 2.13 | 9.5 | 10.6 | 3.5 | 0.07 |
| 7/10/2011 | 12.6 | 18.93 | 6.9 | 7.6 | 6.3 | | 1.63 | 1.97 | 2.4 | 2.4 | 1.2 | <QL |
| 8/10/2011 | 12.84 | 19.88 | 7 | 7.7 | 7 | | 1.28 | 1.67 | 4.6 | 4.9 | 1.2 | 0.05 |
| 9/10/2011 | 12.38 | 21.97 | 7.6 | 7.7 | 5.8 | | 1.62 | 1.69 | 4.1 | 5.2 | 2.5 | 0.16 |
| 10/10/2011 | 13.06 | 20.89 | 6.2 | 6.7 | 5.7 | | 1.32 | 1.58 | 6.4 | 9.2 | 5.9 | <QL |
| Average: | 9.7803 | 13.153 | 7.2787 | 7.5608 | 8.782 | NA | 0.8579 | 1.083 | 7.29 | 8.81 | 2.3842 | 0.1057 |
| 90th Percentile: | 12.446 | 19.215 | 7.86 | 8.1 | 11.6 | NA | 1.779 | 2.148 | 10.4 | 13.4 | 3.5 | 0.16 |
| 10th Percentile: | 7.724 | 10.154 | 6.74 | 7.1 | 6 | NA | 0.157 | 0.221 | 3.95 | 4.43 | 1.1 | 0.06 |
| Max | 15.3 | 21.97 | 8.2 | 8.6 | 13 | NA | 2.04 | 2.76 | 20.1 | 35.6 | 5.9 | 0.42 |

Outfall 104

| | FLOW (MGD) | | pH (S.U.) | |
|---|---|---|---|---|
| Due Date | Quant Avg | Quanti Max | Min | Max |
| 9/10/2008 | NULL | NULL | NULL | NULL |
| 10/10/2008 | NULL | NULL | NULL | NULL |
| 11/10/2008 | 0.16 | 0.16 | 9.2 | 9.2 |
| 12/10/2008 | 0.16 | 0.16 | 9.3 | 9.3 |
| 1/10/2009 | 0.16 | 0.16 | 9.4 | 9.4 |
| 2/10/2009 | 0.16 | 0.16 | 9.5 | 9.5 |
| 3/10/2009 | 0.19 | 0.31 | 9.5 | 9.5 |
| 4/10/2009 | 1 | 1.7 | 8.9 | 10.2 |
| 5/10/2009 | NULL | NULL | NULL | NULL |
| 6/10/2009 | NULL | NULL | NULL | NULL |
| 7/10/2009 | NULL | NULL | NULL | NULL |
| 8/10/2009 | NULL | NULL | NULL | NULL |
| 9/10/2009 | NULL | NULL | NULL | NULL |
| 10/10/2009 | NULL | NULL | NULL | NULL |
| 11/10/2009 | NULL | NULL | NULL | NULL |
| 12/10/2009 | NULL | NULL | NULL | NULL |
| 1/10/2010 | NULL | NULL | NULL | NULL |
| 2/10/2010 | NULL | NULL | NULL | NULL |
| 3/10/2010 | NULL | NULL | NULL | NULL |
| 4/10/2010 | NULL | NULL | NULL | NULL |
| 5/10/2010 | 1.29 | 1.29 | 10.6 | 10.6 |
| 6/10/2010 | NULL | NULL | NULL | NULL |
| 7/10/2010 | NULL | NULL | NULL | NULL |
| 8/10/2010 | NULL | NULL | NULL | NULL |
| 9/10/2010 | NULL | NULL | NULL | NULL |
| 10/10/2010 | NULL | NULL | NULL | NULL |
| 11/10/2010 | 1.75 | 1.75 | 8.8 | 8.8 |
| 12/10/2010 | 0.55 | 0.55 | 10.6 | 10.6 |
| 1/10/2011 | NULL | NULL | NULL | NULL |
| 2/10/2011 | 0.55 | 0.55 | 10.4 | 10.4 |
| 3/10/2011 | 1.7 | 1.7 | 11.4 | 11.4 |
| 4/10/2011 | NULL | NULL | NULL | NULL |
| 5/10/2011 | 0.55 | 0.55 | 11.3 | 11.3 |
| 6/10/2011 | 3.2 | 3.2 | 11.6 | 11.6 |
| 7/10/2011 | NULL | NULL | NULL | NULL |
| 8/10/2011 | NULL | NULL | NULL | NULL |
| 9/10/2011 | NULL | NULL | NULL | NULL |
| 10/10/2011 | 3.23 | 3.23 | 9.4 | 10.4 |
| Average: | 1.046429 | 1.105 | 9.99286 | 10.1571 |
| 90th Percentile: | 2.765 | 2.765 | 11.37 | 11.37 |
| 10th Percentile: | 0.16 | 0.16 | 8.99 | 9.23 |
| Max | 3.23 | 3.23 | 11.6 | 11.6 |

Outfall 005

| | FLOW (MGD) | | pH (S.U.) | | AMMONIA (kg/d) | |
|---|---|---|---|---|---|---|
| Due Date | Quant Avg | Quanti Max | Min | Max | Quant Avg | Quant Max |
| 9/10/2008 | NULL | NULL | NULL | NULL | NULL | NULL |
| 10/10/2008 | NULL | NULL | NULL | NULL | NULL | NULL |
| 11/10/2008 | NULL | NULL | NULL | NULL | NULL | NULL |
| 12/10/2008 | NULL | NULL | NULL | NULL | NULL | NULL |
| 1/10/2009 | NULL | NULL | NULL | NULL | NULL | NULL |
| 2/10/2009 | 2.24 | 4.05 | 7.8 | 8.1 | <QL | <QL |
| 3/10/2009 | NULL | NULL | NULL | NULL | NULL | NULL |
| 4/10/2009 | NULL | NULL | NULL | NULL | NULL | NULL |
| 5/10/2009 | NULL | NULL | NULL | NULL | NULL | NULL |
| 6/10/2009 | NULL | NULL | NULL | NULL | NULL | NULL |
| 7/10/2009 | NULL | NULL | NULL | NULL | NULL | NULL |
| 8/10/2009 | NULL | NULL | NULL | NULL | NULL | NULL |
| 9/10/2009 | NULL | NULL | NULL | NULL | NULL | NULL |
| 10/10/2009 | NULL | NULL | NULL | NULL | NULL | NULL |
| 11/10/2009 | NULL | NULL | NULL | NULL | NULL | NULL |
| 12/10/2009 | NULL | NULL | NULL | NULL | NULL | NULL |
| 1/10/2010 | NULL | NULL | NULL | NULL | NULL | NULL |
| 2/10/2010 | 2.77 | 5.25 | 8 | 8 | <QL | <QL |
| 3/10/2010 | NULL | NULL | NULL | NULL | NULL | NULL |
| 4/10/2010 | 2.01 | 5.96 | 7.8 | 7.8 | <QL | <QL |
| 5/10/2010 | NULL | NULL | NULL | NULL | NULL | NULL |
| 6/10/2010 | NULL | NULL | NULL | NULL | NULL | NULL |
| 7/10/2010 | NULL | NULL | NULL | NULL | NULL | NULL |
| 8/10/2010 | NULL | NULL | NULL | NULL | NULL | NULL |
| 9/10/2010 | NULL | NULL | NULL | NULL | NULL | NULL |
| 10/10/2010 | NULL | NULL | NULL | NULL | NULL | NULL |
| 11/10/2010 | NULL | NULL | NULL | NULL | NULL | NULL |
| 12/10/2010 | NULL | NULL | NULL | NULL | NULL | NULL |
| 1/10/2011 | NULL | NULL | NULL | NULL | NULL | NULL |
| 2/10/2011 | 1.68 | 4.05 | 7.6 | 7.8 | 0.77 | 0.77 |
| 3/10/2011 | NULL | NULL | NULL | NULL | NULL | NULL |
| 4/10/2011 | NULL | NULL | NULL | NULL | NULL | NULL |
| 5/10/2011 | NULL | NULL | NULL | NULL | NULL | NULL |
| 6/10/2011 | NULL | NULL | NULL | NULL | NULL | NULL |
| 7/10/2011 | NULL | NULL | NULL | NULL | NULL | NULL |
| 8/10/2011 | NULL | NULL | NULL | NULL | NULL | NULL |
| 9/10/2011 | NULL | NULL | NULL | NULL | NULL | NULL |
| 10/10/2011 | NULL | NULL | NULL | NULL | NULL | NULL |
| Average: | 2.175 | 4.83 | 7.8 | 7.925 | 0.77 | 0.77 |
| 90th Percentile: | 2.611 | 5.747 | 7.94 | 8.07 | 0.77 | 0.77 |
| 10th Percentile: | 1.779 | 4.05 | 7.66 | 7.8 | 0.77 | 0.77 |
| Max | 2.77 | 5.96 | 8 | 8.1 | 0.77 | 0.77 |

| Form 2C Data (Observed Pollutants) | | | | | | |
|---|---|---|---|---|---|---|
| Pollutant | 001 | 002 | 003 | 004 | 005 | 104 |
| Chemical Oxygen Demand (COD) (mg/L) | 10.13 | | | | 41.93 | |
| Total Organic Carbon (TOC) (mg/L) | 5.1 | 8.6 | 4.8 | 13.3 | 7 | 15 |
| Total Suspended Solids (TSS) (mg/L) | 13.6 | 15 | 12.4 | 51.5 | 15.9 | 19.2 |
| Total Ammonia (mg/L) | 0.1 | 0.07 | 0.08 | 2.76 | 0.07 | 8.9 |
| Temperature, Winter (degrees C) | 11.4 | 18.3 | 16.4 | 12.15 | 5.7 | 13.2 |
| Temperature, Summer (degrees C) | 34 | 37.5 | 42.8 | 32.2 | 31.5 | 31.5 |
| pH (s.u.) | 7.7 | 7.6 | 7.7 | 6 - 8.4 | 7.5 - 9.6 | 8.9 - 12.2 |
| Total Bromide (mg/L) | 0.34 | 0.33 | 0.33 | 0.47 | 0.2 | |
| Color (NTU) | 25 | 30 | 20 | 0 | 25 | 15 |
| Fluoride (mg/L) | 0.146 | 0.154 | 0.141 | 0.399 | 0.184 | 0.799 |
| Nitrate + Nitrite (mg/L) | 0.81 | 0.78 | 0.86 | 1.73 | 0.03 | 53.45 |
| Total Nitrogen (as N) (mg/L) | 0.46 | 0.36 | 0.43 | 2.86 | 0.33 | 4.39 |
| Total Phosphorus (as P) (mg/L) | 0.11 | 0.11 | 0.1 | 0.49 | 0.12 | |
| Total Beta (pCi/L) | 3.69 | 2.45 | 3.23 | 4.44 | 2.88 | 33.6 |
| Sulfate (mg/L) | 54.52 | 55.82 | 57.2 | 150.31 | 76.58 | 644.6 |
| Sulfite (as SO3) (mg/L) | 0.64 | 0.64 | 1.28 | | | |
| Surfactants (mg/L) | | | | | | 2.1 |
| Total Aluminum (mg/L) | 0.23 | 0.11 | 0.21 | 0.24 | 0.26 | 0.11 |
| Total Barium (mg/L) | 0.105 | 0.1 | 0.121 | 0.343 | 0.177 | 0.062 |
| Total Boron (mg/L) | 0.1 | 0.07 | 0.07 | 2.21 | 0.22 | 37.67 |
| Total Cobalt (mg/L) | | | | 0.006 | | |
| Total Iron (mg/L) | 0.7 | 0.5 | 0.56 | 0.07 | 0.39 | 0.63 |
| Total Magnesium (mg/L) | 5.25 | 5.17 | 5.54 | 9.7 | 6.94 | 220 |
| Total Molybdenum (mg/L) | 0.002 | 0.002 | 0.002 | 0.113 | 0.01 | 0.016 |
| Total Manganese (mg/L) | 0.06 | 0.05 | 0.06 | 0.08 | 0.08 | 0.41 |
| Total Tin (mg/L) | | | | | 0.005 | |
| Total Titanium (mg/L) | | | | 0.029 | 0.004 | |
| Total Antimony (mg/L) | | | | 0.008 | | |
| Total Arsenic (mg/L) | | | | 0.054 | 0.006 | 0.007 |
| Total Beryllium (mg/L) | | | | 0.0004 | | |
| Total Cadmium (mg/L) | | | | 0.0012 | | |
| Total Chromium (mg/L) | | | | 0.002 | | |
| Total Copper (mg/L) | 0.014 | 0.037 | 0.004 | 0.009 | | |
| Total Mercury (mg/L) | 0.00000126 | 0.00000119 | 0.00000208 | | | |
| Total Nickel (mg/L) | | | | 0.025 | | 0.056 |
| Total Selenium (mg/L) | | | | 0.019 | 0.006 | 0.116 |
| Total Thallium (mg/L) | | | | 0.0007 | 0.0006 | |
| Total Zinc (mg/L) | 0.013 | 0.012 | 0.01 | 0.033 | | |
| Total Phenols (mg/L) | 0.01 | 0.06 | 0.04 | | 0.01 | |
| Chloroform (mg/L) | 0.00188 | 0.0016 | 0.00189 | | | |
| Gross Alpha Particle Activity (pCi/L) | | | | 4.44 | | |
| Tritium (pCi/L) | | | | | 977 | |
| Beta Particle & Photon Activity (pCi/L) | 3.69 | | 3.23 | | 2.88 | |
| Ammonia (µg/L) | 100 | 70 | 80 | 2360 | 10 | |
| Chlorides (µg/L) | 30440 | 32010 | 32060 | 118320 | 4840 | |
| E. coli (N/100mL) | 50 | 30 | 30 | | | |
| Tributyltin (µg/L) | | | | 0.032 | 0.030 | |
| dissolved antimony (µg/L) | | | | 8.00 | | |
| dissolved arsenic (µg/L) | | | | 41.00 | 5.00 | |
| dissolved cadmium (µg/L) | | | | 1.10 | | |
| dissolved total chromium (µg/L) | | | | 2.00 | | |
| dissolved copper (µg/L) | 6.00, <1.00 | 13.00, 4.00 | 2.00 | 8.00 | | |
| dissolved, mercury (µg/L) | 0.00064 | 0.00094 | 0.00116 | | | |
| dissolved nickel (µg/L) | | | | 25.00 | | |
| dissolved selenium (µg/L) | | | | 17.00 | 4.00 | |
| dissolved thallium (µg/L) | | | | 0.50 | 0.50 | |
| dissolved zinc (µg/L) | 13 | 26 | | 26.00 | | |

| Observed Pollutatnts that are addressed in the Water Quality Standards (See Reasonable Potential Evaluations in Attachment 5) | | | | | |
|---|---|---|---|---|---|
| Pollutants | Outfall 001 (11/12/08) | Outfall 002 (11/12/08) | Outfall 003 (11/12/08) | Outfall 004 (1/26/09) | Outfall 005 (1/12/09) |
| Dissolved Antimony (ug/L) | | | | 8.00 | |
| Dissolved Arsenic (ug/L) | | | | 41.00 | 5.00 |
| Dissolved Cadmium(ug/L) | | | | 1.10 | |
| Total Chromium (ug/L) | | | | 2.00 | |
| Dissolved Copper (ug/L) | 6.00, <1.0 * | 13.00,4.00 * | 2.00 | 8.00 | |
| Dissolved Mercury (ug/L) | 0.00064 | 0.00094 | 0.00116 | | |
| Dissolved Nickel (ug/L) | | | | 25.00 | |
| Total Selenium (ug/L) | | | | 19 | 6 |
| Dissolved Thallium | | | | 0.50 | 0.50 |
| Dissolved Zinc (ug/L) | 13.00 | 26.00 | | 26.00 | |
| Chloroform (ug/L) | 1.88 | 1.60 | 1.89 | | |
| Beta Particle and Photon Activity (pCi/L) | 3.69 | | 3.23 | | 2.88 |
| Gross Alpha Particle Activity (pCi/L) | | | | 4.44 | |
| Ammonia (ug/L) | 100 | 70 | 80 | 2360 | 10.00 |
| Sulfate (mg/L) | 54.52 | 55.82 | 57.2 | 150.31 | 76.58 |
| Total Iron (mg/L) | 0.7 | 0.5 | 0.56 | 0.07 | 0.39 |
| Total Manganese (mg/L) | 0.06 | 0.05 | 0.06 | 0.08 | 0.08 |
| Total Barium (mg/L) | 0.105 | 0.1 | 0.121 | 0.343 | 0.177 |
| Chlorides (ug/L) | 30440 | 32010 | 32060 | 118320 | 4840 |
| E. coli (N/CML) | 50 | 30 | 30 | | |
| Tributyltin (ug/L) | | | | 0.032 | 0.030 |

*Sample collected 4/6/09

PWS only
PWS and Aquatic
PWS and HH
Aquatic
Aquatic, PWS and HH

004 and 005 were grab samples. In addition to the hardness data for the toxicity testing samples, hardness was also measured in grab samples that were collected from Outfalls 001 and 002 on April 6, 2009. These data are also presented the following table.

**Hardness Measurements Taken on Samples Used in Whole Effluent Toxicity Tests with Chesterfield Power Station Outfalls**

| | OUTFALLS 001, 002, 003, 004, and 005 Hardness (mg/L as CaCO3) | | | | |
|---|---|---|---|---|---|
| **Sample Date** | **001** | **002** | **003** | **004** | **005** |
| 6/22/2005 | 92 | 62 | 84 | | |
| 6/24/2005 | 68 | 84 | 80 | | |
| 6/27/2005 | 88 | 68 | 78 | 128 | |
| 5/22/2006 | | | | 118 | |
| 5/26/2006 | | | | 98 | |
| 6/7/2006 | 76 | 84 | 80 | | |
| 6/9/2006 | 88 | 78 | 96 | | |
| 6/12/2006 | 90 | 98 | 104 | 128 | |
| 8/2/2006 | | | | | 48 |
| 9/11/2006 | | | | 82 | |
| 9/13/2006 | | | | 84 | |
| 11/6/2006 | | | | 126 | |
| 11/8/2006 | | | | 86 | |
| 11/9/2006 | | | | 96 | |
| 12/4/2006 | | | | 86 | |
| 12/6/2006 | | | | 108 | |
| 3/20/2007 | | | | | 124 |
| 1/23/2008 | 126 | 112 | 128 | 132 | |
| 1/25/2008 | 108 | 104 | 112 | 136 | |
| 1/28/2008 | 118 | 122 | 136 | 134 | |
| 2/1/2008 | | | | 138 | |
| 3/4/2008 | | | | | 118 |
| 7/16/2008 | 108 | 92 | 162 | 84 | |
| 7/18/2008 | 90 | 72 | 88 | 172 | |
| 7/21/2008 | 118 | 116 | 114 | 192 | |
| 1/12/2009 | | | | | 146 |
| 2/16/2009 | | | | 460* | |
| 2/18/2009 | | | | 448* | |
| 2/1/2009 | | | | 420* | |
| 4/6/2009 | 48 | 48 | | | |
| **Average** | **94** | **88** | **105** | **165** | **109** |

*The increase in the hardness of Outfall 004 between July 2008 and Februrary 2009 is most likely due to the contribution of the station's FGD Chloride Purge Stream wastewater treatment plant, which came on-line during this period.

## Outfall 001 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL[1] | RESULT (ug/L) | SAMPLE TYPE[2] |
|---|---|---|---|---|
| **METALS** | | | | |
| Antimony, dissolved | (3) | 700 | <1.00 | G |
| Arsenic, dissolved | (3) | 270 | <3.00 | G |
| Cadmium, dissolved | (3) | 2.3 | <0.30 | G |
| Chromium III, dissolved [8] | (3) | 360 | <1.00[A] | G |
| Chromium VI, dissolved [8] | (3) | 13 | <1.00 | G |
| Copper, dissolved | (3) | 8.3 | 6.00 B<br><1.00 | G |
| Lead, dissolved | (3) | 67 | <1.00 | G |
| Mercury, dissolved | (3) | 1.1 | 0.00064 | G |
| Nickel, dissolved | (3) | 120 | <5.00 | G |
| Selenium, dissolved | (3) | 16 | <3.00 | G |
| Silver, dissolved | (3) | 1.7 | <0.10 | G |
| Thallium, dissolved | (4) | 320 | <0.20 | G |
| Zinc, dissolved | (3) | 74 | 13.00 | G |
| **PESTICIDES / PCBs** | | | | |
| Aldrin | 608 | 0.05 | <0.016 | G |
| Chlordane | 608 | 0.2 | <0.014 | G |
| Chlorpyrifos (Dursban) | 622 | (5) | <0.014 | G |
| DDD | 608 | 0.1 | <0.021 | G |
| DDE | 608 | 0.1 | <0.017 | G |
| DDT | 608 | 0.1 | <0.017 | G |
| Demeton | (4) | (5) | <0.521 | G |
| Dieldrin | 608 | 0.1 | <0.010 | G |
| Alpha-Endosulfan | 608 | 0.1 | <0.014 | G |
| Beta-Endosulfan | 608 | 0.1 | <0.017 | G |
| Endosulfan Sulfate | 608 | 0.1 | <0.009 | G |
| Endrin | 608 | 0.1 | <0.020 | G |
| Endrin Aldehyde | (4) | (5) | <0.019 | G |

| Outfall 001 Analytical Data for Water Quality Criteria Parameters | | | | |
|---|---|---|---|---|
| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL(1) | RESULT (ug/L) | SAMPLE TYPE(2) |
| Guthion | 622 | (5) | <0.3577 | G |
| Heptachlor | 608 | 0.05 | <0.016 | G |
| Heptachlor Epoxide | (4) | (5) | <0.012 | G |
| Hexachlorocyclohexane Alpha-BHC | 608 | (5) | <0.007 | G |
| Hexachlorocyclohexane Beta-BHC | 608 | (5) | <0.013 | G |
| HexachlorocyclohexaneGamma-BHC (Lindane) | 608 | (5) | <0.011 | G |
| Kepone | (9) | (5) | <0.015 | G |
| Malathion | (4) | (5) | <0.123 | G |
| Methoxychlor | (4) | (5) | <0.017 | G |
| Mirex | (4) | (5) | <0.015 | G |
| Parathion | (4) | (5) | <0.121 | G |
| PCB 1260 | 608 | 1.0 | <1.00 | G |
| PCB 1254 | 608 | 1.0 | <1.00 | G |
| PCB 1248 | 608 | 1.0 | <1.00 | G |
| PCB 1242 | 608 | 1.0 | <1.00 | G |
| PCB 1232 | 608 | 1.0 | <1.00 | G |
| PCB 1221 | 608 | 1.0 | <1.00 | G |
| PCB 1016 | 608 | 1.0 | <1.00 | G |
| PCB Total | 608 | 7.0 | <7.00 | G |
| Toxaphene | 608 | 5.0 | <0.057 | G |
| **BASE NEUTRALS** | | | | |
| Acenaphthene | 625 | 10.0 | <3.00 | G |
| Anthracene | 625 | 10.0 | <1.90 | G |
| Benzidine | (4) | (5) | <63.00 | G |
| Benzo (a) anthracene | 625 | 10.0 | <7.80 | G |
| Benzo (b) fluoranthene | 625 | 10.0 | <4.80 | G |
| Benzo (k) fluoranthene | 625 | 10.0 | <2.50 | G |
| Benzo (a) pyrene | 625 | 10.0 | <2.50 | G |

| Outfall 001 Analytical Data for Water Quality Criteria Parameters | | | | |
|---|---|---|---|---|
| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL[1] | RESULT (ug/L) | SAMPLE TYPE[2] |
| Bis 2-Chloroethyl Ether | (4) | (5) | <5.70 | G |
| Bis 2-Chloroisopropyl Ether | (4) | (5) | <5.70 | G |
| Butyl benzyl phthalate | 625 | 10.0 | <2.50 | G |
| 2-Chloronaphthalene | (4) | (5) | <4.60 | G |
| Chrysene | 625 | 10.0 | <2.50 | G |
| Dibenz(a,h)anthracene | 625 | 20.0 | <2.50 | G |
| Dibutyl phthalate (Di-n-Butyl Phthalate) | 625 | 10.0 | <6.40 | G |
| 1,2-Dichlorobenzene | 624 | 10.0 | <4.00 | G |
| 1,3-Dichlorobenzene | 624 | 10.0 | <3.10 | G |
| 1,4-Dichlorobenzene | 624 | 10.0 | <4.40 | G |
| 3,3-Dichlorobenzidine | (4) | (5) | <16.50 | G |
| Diethyl phthalate | 625 | 10.0 | <7.40 | G |
| Di-2-Ethylhexyl Phthalate | 625 | 10.0 | <2.50 | G |
| Dimethyl phthalate | (4) | (5) | <7.50 | G |
| 2,4-Dinitrotoluene | 625 | 10.0 | <5.70 | G |
| 1,2-Diphenylhydrazine | (4) | (5) | <8.80 | G |
| Fluoranthene | 625 | 10.0 | <2.20 | G |
| Fluorene | 625 | 10.0 | <3.10 | G |
| Hexachlorobenzene | (4) | (5) | <1.80 | G |
| Hexachlorobutadiene | (4) | (5) | <10.00 | G |
| Hexachlorocyclopentadiene | (4) | (5) | <2.40 | G |
| Hexachloroethane | (4) | (5) | <3.70 | G |
| Indeno(1,2,3-cd)pyrene | 625 | 20.0 | <3.70 | G |
| Isophorone | 625 | 10.0 | <5.10 | G |
| Nitrobenzene | 625 | 10.0 | <4.20 | G |
| N-Nitrosodimethylamine | (4) | (5) | <6.20 | G |
| N-Nitrosodi-n-propylamine | (4) | (5) | <3.60 | G |
| N-Nitrosodiphenylamine | (4) | (5) | <2.70 | G |

| Outfall 001 Analytical Data for Water Quality Criteria Parameters | | | | |
|---|---|---|---|---|
| **CHEMICAL** | **EPA ANALYSIS NO.** | **QUANTIFICATION LEVEL[1]** | **RESULT (ug/L)** | **SAMPLE TYPE[2]** |
| Pyrene | 625 | 10.0 | <3.80 | G |
| 1,2,4-Trichlorobenzene | 625 | 10.0 | <7.90 | G |
| **VOLATILES** | | | | |
| Acrolein | (4) | (5) | <10.00 | G |
| Acrylonitrile | (4) | (5) | <1.50 | G |
| Benzene | 624 | 10.0 | <4.40 | G |
| Bromoform | 624 | 10.0 | <4.70 | G |
| Chlorobenzene (monochlorobenzene) | 624 | 50.0 | <6.00 | G |
| Chlorodibromomethane | 624 | 10.0 | <3.10 | G |
| Chloroform | 624 | 10.0 | 1.88 | G |
| Dichloromethane (methylene chloride) | 624 | 20.0 | <2.80 | G |
| Dichlorobromomethane | 624 | 10.0 | <2.20 | G |
| 1,2-Dichloroethane | 624 | 10.0 | <2.80 | G |
| 1,1-Dichloroethylene | 624 | 10.0 | <2.80 | G |
| 1,2-trans-dichloroethylene | (4) | (5) | <1.60 | G |
| 1,2-Dichloropropane | (4) | (5) | <6.00 | G |
| 1,3-Dichloropropene | (4) | (5) | <5.90 | G |
| Ethylbenzene | 624 | 10.0 | <7.20 | G |
| Methyl Bromide | (4) | (5) | <1.40 | G |
| 1,1,2,2-Tetrachloroethane | (4) | (5) | <6.90 | G |
| Tetrachloroethylene | 624 | 10.0 | <4.10 | G |
| Toluene | 624 | 10.0 | <6.00 | G |
| 1,1,2-Trichloroethane | (4) | (5) | <5.00 | G |
| Trichloroethylene | 624 | 10.0 | <1.90 | G |
| **RADIONUCLIDES** | | | | |
| Strontium 90 (pCi/L) | (4) | (5) | <0.87 | G |
| Tritium (pCi/L) | (4) | (5) | <217 | G |
| Beta Particle & Photon Activity (pCi/L) | (4) | (5) | 3.69 | G |

| Outfall 001 Analytical Data for Water Quality Criteria Parameters | | | | |
|---|---|---|---|---|
| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL[1] | RESULT (ug/L) | SAMPLE TYPE[2] |
| Gross Alpha Particle Activity (pCi/L) | (4) | (5) | <0.98 | G |
| ACIDS | | | | |
| 2-Chlorophenol | 625 | 10.0 | <3.30 | G |
| 2,4 Dichlorophenol | 625 | 10.0 | <5.60 | G |
| 2,4 Dimethylphenol | 625 | 10.0 | <5.20 | G |
| 2,4-Dinitrophenol | (4) | (5) | <42.00 | G |
| 2-Methyl-4,6-Dinitrophenol | (4) | (5) | <24.00 | G |
| Pentachlorophenol | 625 | 50.0 | <3.60 | G |
| Phenol | 625 | 10.0 | <2.70 | G |
| 2,4,6-Trichlorophenol | 625 | 10.0 | <2.70 | G |
| MISCELLANEOUS | | | | |
| Ammonia as NH3-N | 350.1 | 200 | 100 | G |
| Chlorides | (4) | (5) | 30,440 | G |
| Chlorine, Total Residual | (4) | 100 | < 100 | G |
| Cyanide, Total | (4) | 10.0 | <10.00 | G |
| *E. coli / Enterococcus* (N/CML) | (4) | (5) | 50 | G |
| Hydrogen Sulfide | (4) | (5) | <50 | G |
| Tributyltin [7] | NBSR 85-3295 | (5) | <0.030 | G |

A = Result is for total chromium
B = Samples for copper analysis were collected from Outfall 001 on 04/06/09 (<1.0 ug/L) and 11/12/09 (6.0 ug/L)

(1) Quantification level (QL) is defined as the lowest concentration used for the calibration of a measurement system when the calibration is in accordance with the procedures published for the required method.

The quantification levels indicated for the metals are actually Specific Target Values developed for this permit. The Specific Target Value is the approximate value that may initiate a wasteload allocation analysis. Target values are not wasteload allocations or effluent limitations. The Specific Target Values are subject to change based on additional information such as hardness data, receiving stream flow, and design flows.

Units for the quantification level are micrograms/liter unless otherwise specified.

Quality control and quality assurance information shall be submitted to document that the required quantification level has been attained.

(2) Sample Type

G = Grab = An individual sample collected in less than 15 minutes. Substances specified with "grab" sample type shall only be collected as grabs. The permittee may analyze multiple grabs and report the average results provided that the individual grab results are also reported. For grab metals samples, the individual samples shall be filtered and preserved immediately upon collection.

C = Composite = A 24-hour **(PW - Revise as required to require same composite duration as $BOD_5$)** composite unless otherwise specified. The composite shall be a combination of individual samples, taken proportional to flow, obtained at hourly or smaller time intervals. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period.

SC = Special Composite = samples for base/neutral/acid compounds, PCBs, and pesticides must be collected as 4 individual grab samples taken proportional to flow at 6-hour intervals over the course of one day. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period. Grab samples must be analyzed separately and the concentrations averaged. Alternately, grab samples may be collected in the field and composited in the laboratory if the compositing procedure produces results equivalent to results produced by arithmetic averaging of the results of analysis of individual grab samples.

(3) A specific analytical method is not specified; however a target value for each metal has been established. An appropriate method to meet the target value shall be selected from the following list of EPA methods (or any approved method presented in 40 CFR Part 136). If the test result is less than the method QL, a "<[QL]" shall be reported where the actual analytical test QL is substituted for [QL].

| Metal | Analytical Method |
|---|---|
| Antimony | 1638; 1639 |
| Arsenic | 206.5; 1632 |
| Chromium[9] | 1639 |
| Cadmium | 1637; 1638; 1639; 1640 |
| Chromium VI | 218.6; 1639 |
| Copper | 1638; 1640 |
| Lead | 1637; 1638; 1640 |
| Mercury | 245.7; 1631 |
| Nickel | 1638; 1639; 1640 |
| Selenium | 1638; 1639 |
| Silver | 1638 |
| Zinc | 1638; 1639 |

(4) Any approved method presented in 40 CFR Part 136.

(5) The QL is at the discretion of the permittee. For any substances addressed in 40 CFR Part 136, the permittee shall use one of the approved methods in 40 CFR Part 136.

(6) Testing for phenol requires continuous extraction.

(7) Analytical Methods: NBSR 85-3295 or DEQ's approved analysis for Tributyltin may also be used [See A Manual for the Analysis of Butyltins in Environmental Systems by the Virginia Institute of Marine Science, dated November 1996].

(8) Both Chromium III and Chromium VI may be measured by the total chromium analysis. If the result of the total chromium analysis is less than or equal to the lesser of the Chromium III or Chromium VI method QL, the results for both Chromium III and Chromium VI can be reported as "<[QL]", where the actual analytical test QL is substituted for [QL].

(9) The lab may use SW846 Method 8270D provided the lab has an Initial Demonstration of Capability, has passed a PT for Kepone, and meets the acceptance criteria for Kepone as given in Method 8270D

# Outfall 002 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL[1] | RESULT (ug/L) | SAMPLE TYPE[2] |
|---|---|---|---|---|
| **METALS** | | | | |
| Antimony, dissolved | (3) | 700 | <1.00 | G |
| Arsenic, dissolved | (3) | 270 | <3.00 | G |
| Cadmium, dissolved | (3) | 2.3 | <0.30 | G |
| Chromium III, dissolved [8] | (3) | 360 | <1.00 [A] | G |
| Chromium VI, dissolved [8] | (3) | 13 | <10.00 | G |
| Copper, dissolved | (3) | 8.3 | 13.00 [B]<br>4.00 | G |
| Lead, dissolved | (3) | 67 | <1.00 | G |
| Mercury, dissolved | (3) | 1.1 | 0.00094 | G |
| Nickel, dissolved | (3) | 120 | <5.00 | G |
| Selenium, dissolved | (3) | 16 | <3.00 | G |
| Silver, dissolved | (3) | 1.7 | <0.10 | G |
| Thallium, dissolved | (4) | 320 | <0.20 | G |
| Zinc, dissolved | (3) | 74 | 26.00 | G |
| **PESTICIDES / PCBs** | | | | |
| Aldrin | 608 | 0.05 | <0.016 | G |
| Chlordane | 608 | 0.2 | <0.014 | G |
| Chlorpyrifos (Dursban) | 622 | (5) | <0.014 | G |
| DDD | 608 | 0.1 | <0.021 | G |
| DDE | 608 | 0.1 | <0.017 | G |
| DDT | 608 | 0.1 | <0.017 | G |
| Demeton | (4) | (5) | <0.521 | G |
| Dieldrin | 608 | 0.1 | <0.010 | G |
| Alpha-Endosulfan | 608 | 0.1 | <0.014 | G |
| Beta-Endosulfan | 608 | 0.1 | <0.017 | G |
| Endosulfan Sulfate | 608 | 0.1 | <0.009 | G |
| Endrin | 608 | 0.1 | <0.020 | G |

## Outfall 002 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL(1) | RESULT (ug/L) | SAMPLE TYPE(2) |
|---|---|---|---|---|
| Endrin Aldehyde | (4) | (5) | <0.019 | G |
| Guthion | 622 | (5) | <0.3577 | G |
| Heptachlor | 608 | 0.05 | <0.016 | G |
| Heptachlor Epoxide | (4) | (5) | <0.012 | G |
| Hexachlorocyclohexane Alpha-BHC | 608 | (5) | <0.007 | G |
| Hexachlorocyclohexane Beta-BHC | 608 | (5) | <0.013 | G |
| HexachlorocyclohexaneGamma-BHC (Lindane) | 608 | (5) | <0.011 | G |
| Kepone | (9) | (5) | <0.015 | G |
| Malathion | (4) | (5) | <0.123 | G |
| Methoxychlor | (4) | (5) | <0.017 | G |
| Mirex | (4) | (5) | <0.015 | G |
| Parathion | (4) | (5) | <0.121 | G |
| PCB 1260 | 608 | 1.0 | <1.00 | G |
| PCB 1254 | 608 | 1.0 | <1.00 | G |
| PCB 1248 | 608 | 1.0 | <1.00 | G |
| PCB 1242 | 608 | 1.0 | <1.00 | G |
| PCB 1232 | 608 | 1.0 | <1.00 | G |
| PCB 1221 | 608 | 1.0 | <1.00 | G |
| PCB 1016 | 608 | 1.0 | <1.00 | G |
| PCB Total | 608 | 7.0 | <7.00 | G |
| Toxaphene | 608 | 5.0 | <0.057 | G |
| **BASE NEUTRALS** | | | | |
| Acenaphthene | 625 | 10.0 | <3.00 | G |
| Anthracene | 625 | 10.0 | <1.90 | G |
| Benzidine | (4) | (5) | <63.00 | G |
| Benzo (a) anthracene | 625 | 10.0 | <7.80 | G |
| Benzo (b) fluoranthene | 625 | 10.0 | <4.80 | G |
| Benzo (k) fluoranthene | 625 | 10.0 | <2.50 | G |

## Outfall 002 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL(1) | RESULT (ug/L) | SAMPLE TYPE(2) |
|---|---|---|---|---|
| Benzo (a) pyrene | 625 | 10.0 | <2.50 | G |
| Bis 2-Chloroethyl Ether | (4) | (5) | <5.70 | G |
| Bis 2-Chloroisopropyl Ether | (4) | (5) | <5.70 | G |
| Butyl benzyl phthalate | 625 | 10.0 | <2.50 | G |
| 2-Chloronaphthalene | (4) | (5) | <4.60 | G |
| Chrysene | 625 | 10.0 | <2.50 | G |
| Dibenz(a,h)anthracene | 625 | 20.0 | <2.50 | G |
| Dibutyl phthalate (Di-n-Butyl Phthalate) | 625 | 10.0 | <6.40 | G |
| 1,2-Dichlorobenzene | 624 | 10.0 | <4.00 | G |
| 1,3-Dichlorobenzene | 624 | 10.0 | <3.10 | G |
| 1,4-Dichlorobenzene | 624 | 10.0 | <4.40 | G |
| 3,3-Dichlorobenzidine | (4) | (5) | <16.50 | G |
| Diethyl phthalate | 625 | 10.0 | <7.40 | G |
| Di-2-Ethylhexyl Phthalate | 625 | 10.0 | <2.50 | G |
| Dimethyl phthalate | (4) | (5) | <7.50 | G |
| 2,4-Dinitrotoluene | 625 | 10.0 | <5.70 | G |
| 1,2-Diphenylhydrazine | (4) | (5) | <8.80 | G |
| Fluoranthene | 625 | 10.0 | <2.20 | G |
| Fluorene | 625 | 10.0 | <3.10 | G |
| Hexachlorobenzene | (4) | (5) | <1.80 | G |
| Hexachlorobutadiene | (4) | (5) | <10.00 | G |
| Hexachlorocyclopentadiene | (4) | (5) | <2.40 | G |
| Hexachloroethane | (4) | (5) | <3.70 | G |
| Indeno(1,2,3-cd)pyrene | 625 | 20.0 | <3.70 | G |
| Isophorone | 625 | 10.0 | <5.10 | G |
| Nitrobenzene | 625 | 10.0 | <4.20 | G |
| N-Nitrosodimethylamine | (4) | (5) | <6.20 | G |
| N-Nitrosodi-n-propylamine | (4) | (5) | <3.60 | G |

## Outfall 002 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL[1] | RESULT (ug/L) | SAMPLE TYPE[2] |
|---|---|---|---|---|
| N-Nitrosodiphenylamine | (4) | (5) | <2.70 | G |
| Pyrene | 625 | 10.0 | <3.80 | G |
| 1,2,4-Trichlorobenzene | 625 | 10.0 | <7.90 | G |
| **VOLATILES** | | | | |
| Acrolein | (4) | (5) | <10.00 | G |
| Acrylonitrile | (4) | (5) | <1.50 | G |
| Benzene | 624 | 10.0 | <4.40 | G |
| Bromoform | 624 | 10.0 | <4.70 | G |
| Chlorobenzene (monochlorobenzene) | 624 | 50.0 | <6.00 | G |
| Chlorodibromomethane | 624 | 10.0 | <3.10 | G |
| Chloroform | 624 | 10.0 | 1.60 | G |
| Dichloromethane (methylene chloride) | 624 | 20.0 | <2.80 | G |
| Dichlorobromomethane | 624 | 10.0 | <2.20 | G |
| 1,2-Dichloroethane | 624 | 10.0 | <2.80 | G |
| 1,1-Dichloroethylene | 624 | 10.0 | <2.80 | G |
| 1,2-trans-dichloroethylene | (4) | (5) | <1.60 | G |
| 1,2-Dichloropropane | (4) | (5) | <6.00 | G |
| 1,3-Dichloropropene | (4) | (5) | <5.90 | G |
| Ethylbenzene | 624 | 10.0 | <7.20 | G |
| Methyl Bromide | (4) | (5) | <1.40 | G |
| 1,1,2,2-Tetrachloroethane | (4) | (5) | <6.90 | G |
| Tetrachloroethylene | 624 | 10.0 | <4.10 | G |
| Toluene | 624 | 10.0 | <6.00 | G |
| 1,1,2-Trichloroethane | (4) | (5) | <5.00 | G |
| Trichloroethylene | 624 | 10.0 | <1.90 | G |
| **RADIONUCLIDES** | | | | |
| Strontium 90 (pCi/L) | (4) | (5) | <0.92 | G |
| Tritium (pCi/L) | (4) | (5) | <217 | G |

| Outfall 002 Analytical Data for Water Quality Criteria Parameters | | | | |
|---|---|---|---|---|
| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL(1) | RESULT (ug/L) | SAMPLE TYPE(2) |
| Beta Particle & Photon Activity (pCi/L) | (4) | (5) | <0.013 | G |
| Gross Alpha Particle Activity (pCi/L) | (4) | (5) | <0.007 | G |
| **ACIDS** | | | | |
| 2-Chlorophenol | 625 | 10.0 | <3.30 | G |
| 2,4 Dichlorophenol | 625 | 10.0 | <5.60 | G |
| 2,4 Dimethylphenol | 625 | 10.0 | <5.20 | G |
| 2,4-Dinitrophenol | (4) | (5) | <42.00 | G |
| 2-Methyl-4,6-Dinitrophenol | (4) | (5) | <24.00 | G |
| Pentachlorophenol | 625 | 50.0 | <3.60 | G |
| Phenol | 625 | 10.0 | <2.70 | G |
| 2,4,6-Trichlorophenol | 625 | 10.0 | <2.70 | G |
| **MISCELLANEOUS** | | | | |
| Ammonia as NH3-N | 350.1 | 200 | 70 | C |
| Chlorides | (4) | (5) | 32,010 | C |
| Chlorine, Total Residual | (4) | 100 | < 100 | G |
| Cyanide, Total | (4) | 10.0 | <10.00 | G |
| *E. coli / Enterococcus* (N/CML) | (4) | (5) | 30 | G |
| Hydrogen Sulfide | (4) | (5) | <50.00 | G |
| Tributyltin (7) | NBSR 85-3295 | (5) | <0.030 | G |

A = Result is for Total Chromium
B = Samples for copper analysis were collected from Outfall 002 on 04/06/09 (4 ug/L) and on 11/12/08 (13 ug/L)

(1) Quantification level (QL) is defined as the lowest concentration used for the calibration of a measurement system when the calibration is in accordance with the procedures published for the required method.

The quantification levels indicated for the metals are actually Specific Target Values developed for this permit. The Specific Target Value is the approximate value that may initiate a wasteload allocation analysis. Target values are not wasteload allocations or effluent limitations. The Specific Target Values are subject to change based on additional information such as hardness data, receiving stream flow, and design flows.

Units for the quantification level are micrograms/liter unless otherwise specified.

Quality control and quality assurance information shall be submitted to document that the required quantification level has been attained.

(2) Sample Type

G = Grab = An individual sample collected in less than 15 minutes. Substances specified with "grab" sample type shall only be collected as grabs. The permittee may analyze multiple grabs and report the average results provided that the individual grab results are also reported. For grab metals samples, the individual samples shall be filtered and preserved immediately upon collection.

C = Composite = A 24-hour **(PW - Revise as required to require same composite duration as $BOD_5$)** composite unless otherwise specified. The composite shall be a combination of individual samples, taken proportional to flow, obtained at hourly or smaller time intervals. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period.

SC = Special Composite = samples for base/neutral/acid compounds, PCBs, and pesticides must be collected as 4 individual grab samples taken proportional to flow at 6-hour intervals over the course of one day. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period. Grab samples must be analyzed separately and the concentrations averaged. Alternately, grab samples may be collected in the field and composited in the laboratory if the compositing procedure produces results equivalent to results produced by arithmetic averaging of the results of analysis of individual grab samples.

(3) A specific analytical method is not specified; however a target value for each metal has been established. An appropriate method to meet the target value shall be selected from the following list of EPA methods (or any approved method presented in 40 CFR Part 136). If the test result is less than the method QL, a "<[QL]" shall be reported where the actual analytical test QL is substituted for [QL].

| Metal | Analytical Method |
|---|---|
| Antimony | 1638; 1639 |
| Arsenic | 206.5; 1632 |
| Chromium(9) | 1639 |
| Cadmium | 1637; 1638; 1639; 1640 |
| Chromium VI | 218.6; 1639 |
| Copper | 1638; 1640 |
| Lead | 1637; 1638; 1640 |
| Mercury | 245.7; 1631 |
| Nickel | 1638; 1639; 1640 |
| Selenium | 1638; 1639 |
| Silver | 1638 |
| Zinc | 1638; 1639 |

(4) Any approved method presented in 40 CFR Part 136.

(5) The QL is at the discretion of the permittee. For any substances addressed in 40 CFR Part 136, the permittee shall use one of the approved methods in 40 CFR Part 136.

(6) Testing for phenol requires continuous extraction.

(7) Analytical Methods: NBSR 85-3295 or DEQ's approved analysis for Tributyltin may also be used [See A Manual for the Analysis of Butyltins in Environmental Systems by the Virginia Institute of Marine Science, dated November 1996].

(8) Both Chromium III and Chromium VI may be measured by the total chromium analysis. If the result of the total chromium analysis is less than or equal to the lesser of the Chromium III or Chromium VI method QL, the results for both Chromium III and Chromium VI can be reported as "<[QL]", where the actual analytical test QL is substituted for [QL].

(9) The lab may use SW846 Method 8270D provided the lab has an Initial Demonstration of Capability, has passed a PT for Kepone, and meets the acceptance criteria for Kepone as given in Method 8270D

## Outfall 003 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL(1) | RESULT (ug/L) | SAMPLE TYPE(2) |
|---|---|---|---|---|
| **METALS** | | | | |
| Antimony, dissolved | (3) | 14 | <1.00 | G |
| Arsenic, dissolved | (3) | 10 | <3.00 | G |
| Cadmium, dissolved | (3) | 0.55 | <0.30 | G |
| Chromium III, dissolved (8) | (3) | 36 | <1.00 A | G |
| Chromium VI, dissolved (8) | (3) | 6.4 | <1.00 A | G |
| Copper, dissolved | (3) | 4.2 | 2.00 | G |
| Lead, dissolved | (3) | 5.7 | <1.00 | G |
| Mercury, dissolved | (3) | 1.0 | 0.00116 | G |
| Nickel, dissolved | (3) | 9.6 | <5.00 | G |
| Selenium, dissolved | (3) | 3.0 | <3.00 | G |
| Silver, dissolved | (3) | 0.86 | <0.10 | G |
| Thallium, dissolved | (4) | 6.3 | <0.20 | G |
| Zinc, dissolved | (3) | 37 | <10.00 | G |
| **PESTICIDES / PCBs** | | | | |
| Aldrin | 608 | 0.05 | <0.016 | G |
| Chlordane | 608 | 0.2 | <0.014 | G |
| Chlorpyrifos (Dursban) | 622 | (5) | <0.014 | G |
| DDD | 608 | 0.1 | <0.021 | G |
| DDE | 608 | 0.1 | <0.017 | G |
| DDT | 608 | 0.1 | <0.017 | G |
| Demeton | (4) | (5) | <0.521 | G |
| Dieldrin | 608 | 0.1 | <0.010 | G |
| Alpha-Endosulfan | 608 | 0.1 | <0.014 | G |
| Beta-Endosulfan | 608 | 0.1 | <0.017 | G |
| Endosulfan Sulfate | 608 | 0.1 | <0.009 | G |
| Endrin | 608 | 0.1 | <0.020 | G |
| Endrin Aldehyde | (4) | (5) | <0.019 | G |

## Outfall 003 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL[1] | RESULT (ug/L) | SAMPLE TYPE[2] |
|---|---|---|---|---|
| Guthion | 622 | (5) | <0.3577 | G |
| Heptachlor | 608 | 0.05 | <0.016 | G |
| Heptachlor Epoxide | (4) | (5) | <0.012 | G |
| Hexachlorocyclohexane Alpha-BHC | 608 | (5) | <0.007 | G |
| Hexachlorocyclohexane Beta-BHC | 608 | (5) | <0.013 | G |
| HexachlorocyclohexaneGamma-BHC (Lindane) | 608 | (5) | <0.011 | G |
| Kepone | (9) | (5) | <0.015 | G |
| Malathion | (4) | (5) | <0.123 | G |
| Methoxychlor | (4) | (5) | <0.017 | G |
| Mirex | (4) | (5) | <0.015 | G |
| Parathion | (4) | (5) | <0.121 | G |
| PCB 1260 | 608 | 1.0 | <1.00 | G |
| PCB 1254 | 608 | 1.0 | <1.00 | G |
| PCB 1248 | 608 | 1.0 | <1.00 | G |
| PCB 1242 | 608 | 1.0 | <1.00 | G |
| PCB 1232 | 608 | 1.0 | <1.00 | G |
| PCB 1221 | 608 | 1.0 | <1.00 | G |
| PCB 1016 | 608 | 1.0 | <1.00 | G |
| PCB Total | 608 | 7.0 | <7.00 | G |
| Toxaphene | 608 | 5.0 | <0.057 | G |
| **BASE NEUTRALS** | | | | |
| Acenaphthene | 625 | 10.0 | <3.00 | G |
| Anthracene | 625 | 10.0 | <1.90 | G |
| Benzidine | (4) | (5) | <63.00 | G |
| Benzo (a) anthracene | 625 | 10.0 | <7.80 | G |
| Benzo (b) fluoranthene | 625 | 10.0 | <4.80 | G |
| Benzo (k) fluoranthene | 625 | 10.0 | <2.50 | G |
| Benzo (a) pyrene | 625 | 10.0 | <2.50 | G |

## Outfall 003 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL[1] | RESULT (ug/L) | SAMPLE TYPE[2] |
|---|---|---|---|---|
| Bis 2-Chloroethyl Ether | (4) | (5) | <5.70 | G |
| Bis 2-Chloroisopropyl Ether | (4) | (5) | <5.70 | G |
| Butyl benzyl phthalate | 625 | 10.0 | <2.50 | G |
| 2-Chloronaphthalene | (4) | (5) | <4.60 | G |
| Chrysene | 625 | 10.0 | <2.50 | G |
| Dibenz(a,h)anthracene | 625 | 20.0 | <2.50 | G |
| Dibutyl phthalate (Di-n-Butyl Phthalate) | 625 | 10.0 | <6.40 | G |
| 1,2-Dichlorobenzene | 624 | 10.0 | <4.00 | G |
| 1,3-Dichlorobenzene | 624 | 10.0 | <3.10 | G |
| 1,4-Dichlorobenzene | 624 | 10.0 | <4.40 | G |
| 3,3-Dichlorobenzidine | (4) | (5) | <16.50 | G |
| Diethyl phthalate | 625 | 10.0 | <7.40 | G |
| Di-2-Ethylhexyl Phthalate | 625 | 10.0 | <2.50 | G |
| Dimethyl phthalate | (4) | (5) | <7.50 | G |
| 2,4-Dinitrotoluene | 625 | 10.0 | <5.70 | G |
| 1,2-Diphenylhydrazine | (4) | (5) | <8.80 | G |
| Fluoranthene | 625 | 10.0 | <2.20 | G |
| Fluorene | 625 | 10.0 | <3.10 | G |
| Hexachlorobenzene | (4) | (5) | <1.80 | G |
| Hexachlorobutadiene | (4) | (5) | <10.00 | G |
| Hexachlorocyclopentadiene | (4) | (5) | <2.40 | G |
| Hexachloroethane | (4) | (5) | <3.70 | G |
| Indeno(1,2,3-cd)pyrene | 625 | 20.0 | <3.70 | G |
| Isophorone | 625 | 10.0 | <5.10 | G |
| Nitrobenzene | 625 | 10.0 | <4.20 | G |
| N-Nitrosodimethylamine | (4) | (5) | <6.20 | G |
| N-Nitrosodi-n-propylamine | (4) | (5) | <3.60 | G |
| N-Nitrosodiphenylamine | (4) | (5) | <2.70 | G |

## Outfall 003 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL[1] | RESULT (ug/L) | SAMPLE TYPE[2] |
|---|---|---|---|---|
| Pyrene | 625 | 10.0 | <3.80 | G |
| 1,2,4-Trichlorobenzene | 625 | 10.0 | <7.90 | G |
| **VOLATILES** | | | | |
| Acrolein | (4) | (5) | <10.00 | G |
| Acrylonitrile | (4) | (5) | <1.50 | G |
| Benzene | 624 | 10.0 | <4.40 | G |
| Bromoform | 624 | 10.0 | <4.70 | G |
| Chlorobenzene (monochlorobenzene) | 624 | 50.0 | <6.00 | G |
| Chlorodibromomethane | 624 | 10.0 | <3.10 | G |
| Chloroform | 624 | 10.0 | 1.89 | G |
| Dichloromethane (methylene chloride) | 624 | 20.0 | <2.80 | G |
| Dichlorobromomethane | 624 | 10.0 | <2.20 | G |
| 1,2-Dichloroethane | 624 | 10.0 | <2.80 | G |
| 1,1-Dichloroethylene | 624 | 10.0 | <2.80 | G |
| 1,2-trans-dichloroethylene | (4) | (5) | <1.60 | G |
| 1,2-Dichloropropane | (4) | (5) | <6.00 | G |
| 1,3-Dichloropropene | (4) | (5) | <5.90 | G |
| Ethylbenzene | 624 | 10.0 | <7.20 | G |
| Methyl Bromide | (4) | (5) | <1.40 | G |
| 1,1,2,2-Tetrachloroethane | (4) | (5) | <6.90 | G |
| Tetrachloroethylene | 624 | 10.0 | <4.10 | G |
| Toluene | 624 | 10.0 | <6.00 | G |
| 1,1,2-Trichloroethane | (4) | (5) | <5.00 | G |
| Trichloroethylene | 624 | 10.0 | <1.90 | G |
| **RADIONUCLIDES** | | | | |
| Strontium 90 (pCi/L) | (4) | (5) | <0.90 | G |
| Tritium (pCi/L) | (4) | (5) | <217 | G |
| Beta Particle & Photon Activity (pCi/L) | (4) | (5) | 3.23 | G |

## Outfall 003 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL(1) | RESULT (ug/L) | SAMPLE TYPE(2) |
|---|---|---|---|---|
| Gross Alpha Particle Activity (pCi/L) | (4) | (5) | <1.06 | G |
| **ACIDS** | | | | |
| 2-Chlorophenol | 625 | 10.0 | <3.30 | G |
| 2,4 Dichlorophenol | 625 | 10.0 | <5.60 | G |
| 2,4 Dimethylphenol | 625 | 10.0 | <5.20 | G |
| 2,4-Dinitrophenol | (4) | (5) | <42.00 | G |
| 2-Methyl-4,6-Dinitrophenol | (4) | (5) | <24.00 | G |
| Pentachlorophenol | 625 | 50.0 | <3.60 | G |
| Phenol | 625 | 10.0 | <2.70 | G |
| 2,4,6-Trichlorophenol | 625 | 10.0 | <2.70 | G |
| **MISCELLANEOUS** | | | | |
| Ammonia as NH3-N | 350.1 | 200 | 80 | G |
| Chlorides | (4) | (5) | 32,060 | G |
| Chlorine, Total Residual | (4) | 100 | < 100 | G |
| Cyanide, Total | (4) | 10.0 | <10.00 | G |
| *E. coli / Enterococcus* (N/CML) | (4) | (5) | 30 | G |
| Hydrogen Sulfide | (4) | (5) | <0.05 | G |
| Tributyltin (7) | NBSR 85-3295 | (5) | <0.030 | G |

A = Result is for total chromium

(1) Quantification level (QL) is defined as the lowest concentration used for the calibration of a measurement system when the calibration is in accordance with the procedures published for the required method.

The quantification levels indicated for the metals are actually Specific Target Values developed for this permit. The Specific Target Value is the approximate value that may initiate a wasteload allocation analysis. Target values are not wasteload allocations or effluent limitations. The Specific Target Values are subject to change based on additional information such as hardness data, receiving stream flow, and design flows.

Units for the quantification level are micrograms/liter unless otherwise specified.

Quality control and quality assurance information shall be submitted to document that the required quantification level has been attained.

(2) Sample Type

G = Grab = An individual sample collected in less than 15 minutes. Substances specified with "grab" sample type shall only be collected as grabs. The permittee may analyze multiple grabs and report the average results provided that the individual grab results are also reported. For grab metals samples, the individual samples shall be filtered and preserved immediately upon collection.

C = Composite = A 24-hour **(PW - Revise as required to require same composite duration as $BOD_5$)** composite unless otherwise specified. The composite shall be a combination of individual samples, taken proportional to flow, obtained at hourly or smaller time intervals. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period.

SC = Special Composite = samples for base/neutral/acid compounds, PCBs, and pesticides must be collected as 4 individual grab samples taken proportional to flow at 6-hour intervals over the course of one day. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period. Grab samples must be analyzed separately and the concentrations averaged. Alternately, grab samples may be collected in the field and composited in the laboratory if the compositing procedure produces results equivalent to results produced by arithmetic averaging of the results of analysis of individual grab samples.

(3) A specific analytical method is not specified; however a target value for each metal has been established. An appropriate method to meet the target value shall be selected from the following list of EPA methods (or any approved method presented in 40 CFR Part 136). If the test result is less than the method QL, a "<[QL]" shall be reported where the actual analytical test QL is substituted for [QL].

| Metal | Analytical Method |
|---|---|
| Antimony | 1638; 1639 |
| Arsenic | 206.5; 1632 |
| Chromium[9] | 1639 |
| Cadmium | 1637; 1638; 1639; 1640 |
| Chromium VI | 218.6; 1639 |
| Copper | 1638; 1640 |
| Lead | 1637; 1638; 1640 |
| Mercury | 245.7; 1631 |
| Nickel | 1638; 1639; 1640 |
| Selenium | 1638; 1639 |
| Silver | 1638 |
| Zinc | 1638; 1639 |

(4) Any approved method presented in 40 CFR Part 136.

(5) The QL is at the discretion of the permittee. For any substances addressed in 40 CFR Part 136, the permittee shall use one of the approved methods in 40 CFR Part 136.

(6) Testing for phenol requires continuous extraction.

(7) Analytical Methods: NBSR 85-3295 or DEQ's approved analysis for Tributyltin may also be used [See A Manual for the Analysis of Butyltins in Environmental Systems by the Virginia Institute of Marine Science, dated November 1996].

(8) Both Chromium III and Chromium VI may be measured by the total chromium analysis. If the result of the total chromium analysis is less than or equal to the lesser of the Chromium III or Chromium VI method QL, the results for both Chromium III and Chromium VI can be reported as "<[QL]", where the actual analytical test QL is substituted for [QL].

(9) The lab may use SW846 Method 8270D provided the lab has an Initial Demonstration of Capability, has passed a PT for Kepone, and meets the acceptance criteria for Kepone as given in Method 8270D

# Outfall 004 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL(1) | RESULT (ug/L) | SAMPLE TYPE(2) |
|---|---|---|---|---|
| **METALS** | | | | |
| Antimony, dissolved | (3) | 130,000 | 8.00 | G |
| Arsenic, dissolved | (3) | 2,800 | 41.00 | G |
| Cadmium, dissolved | (3) | 17 | 1.10 | G |
| Chromium III, dissolved (8) | (3) | 1,100 | 2.00 A | G |
| Chromium VI, dissolved (8) | (3) | 200 | <10.00 | G |
| Copper, dissolved | (3) | 130 | 8.00 | G |
| Lead, dissolved | (3) | 180 | <1.00 | G |
| Mercury, dissolved | (3) | 1.6 | <0.20 | G |
| Nickel, dissolved | (3) | 300 | 25.00 | G |
| Selenium, dissolved | (3) | 93 | 17.00 | G |
| Silver, dissolved | (3) | 27 | <0.10 | G |
| Thallium, dissolved | (4) | 200 | 0.50 | G |
| Zinc, dissolved | (3) | 1,200 | 26.00 | G |
| **PESTICIDES / PCBs** | | | | |
| Aldrin | 608 | 0.05 | <0.016 | G |
| Chlordane | 608 | 0.2 | <0.014 | G |
| Chlorpyrifos (Dursban) | 622 | (5) | <0.014 | G |
| DDD | 608 | 0.1 | <0.021 | G |
| DDE | 608 | 0.1 | <0.017 | G |
| DDT | 608 | 0.1 | <0.017 | G |
| Demeton | (4) | (5) | <0.521 | G |
| Dieldrin | 608 | 0.1 | <0.010 | G |
| Alpha-Endosulfan | 608 | 0.1 | <0.014 | G |
| Beta-Endosulfan | 608 | 0.1 | <0.017 | G |
| Endosulfan Sulfate | 608 | 0.1 | <0.009 | G |
| Endrin | 608 | 0.1 | <0.020 | G |
| Endrin Aldehyde | (4) | (5) | <0.019 | G |

| Outfall 004 Analytical Data for Water Quality Criteria Parameters | | | | |
|---|---|---|---|---|
| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL[1] | RESULT (ug/L) | SAMPLE TYPE[2] |
| Guthion | 622 | (5) | <0.3577 | G |
| Heptachlor | 608 | 0.05 | <0.016 | G |
| Heptachlor Epoxide | (4) | (5) | <0.012 | G |
| Hexachlorocyclohexane Alpha-BHC | 608 | (5) | <0.007 | G |
| Hexachlorocyclohexane Beta-BHC | 608 | (5) | <0.013 | G |
| HexachlorocyclohexaneGamma-BHC (Lindane) | 608 | (5) | <0.011 | G |
| Kepone | (9) | (5) | <0.015 | G |
| Malathion | (4) | (5) | <0.123 | G |
| Methoxychlor | (4) | (5) | <0.017 | G |
| Mirex | (4) | (5) | <0.015 | G |
| Parathion | (4) | (5) | <0.121 | G |
| PCB 1260 | 608 | 1.0 | <1.00 | G |
| PCB 1254 | 608 | 1.0 | <1.00 | G |
| PCB 1248 | 608 | 1.0 | <1.00 | G |
| PCB 1242 | 608 | 1.0 | <1.00 | G |
| PCB 1232 | 608 | 1.0 | <1.00 | G |
| PCB 1221 | 608 | 1.0 | <1.00 | G |
| PCB 1016 | 608 | 1.0 | <1.00 | G |
| PCB Total | 608 | 7.0 | <7.00 | G |
| Toxaphene | 608 | 5.0 | <0.057 | G |
| BASE NEUTRALS | | | | |
| Acenaphthene | 625 | 10.0 | <3.00 | G |
| Anthracene | 625 | 10.0 | <1.90 | G |
| Benzidine | (4) | (5) | <63.00 | G |
| Benzo (a) anthracene | 625 | 10.0 | <7.80 | G |
| Benzo (b) fluoranthene | 625 | 10.0 | <4.80 | G |
| Benzo (k) fluoranthene | 625 | 10.0 | <2.50 | G |
| Benzo (a) pyrene | 625 | 10.0 | <2.50 | G |

## Outfall 004 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL[1] | RESULT (ug/L) | SAMPLE TYPE[2] |
|---|---|---|---|---|
| Bis 2-Chloroethyl Ether | (4) | (5) | <5.70 | G |
| Bis 2-Chloroisopropyl Ether | (4) | (5) | <5.70 | G |
| Butyl benzyl phthalate | 625 | 10.0 | <2.50 | G |
| 2-Chloronaphthalene | (4) | (5) | <4.60 | G |
| Chrysene | 625 | 10.0 | <2.50 | G |
| Dibenz(a,h)anthracene | 625 | 20.0 | <2.50 | G |
| Dibutyl phthalate (Di-n-Butyl Phthalate) | 625 | 10.0 | <6.40 | G |
| 1,2-Dichlorobenzene | 624 | 10.0 | <4.00 | G |
| 1,3-Dichlorobenzene | 624 | 10.0 | <3.10 | G |
| 1,4-Dichlorobenzene | 624 | 10.0 | <4.40 | G |
| 3,3-Dichlorobenzidine | (4) | (5) | <16.50 | G |
| Diethyl phthalate | 625 | 10.0 | <7.40 | G |
| Di-2-Ethylhexyl Phthalate | 625 | 10.0 | <2.50 | G |
| Dimethyl phthalate | (4) | (5) | <7.50 | G |
| 2,4-Dinitrotoluene | 625 | 10.0 | <5.70 | G |
| 1,2-Diphenylhydrazine | (4) | (5) | <8.80 | G |
| Fluoranthene | 625 | 10.0 | <2.20 | G |
| Fluorene | 625 | 10.0 | <3.10 | G |
| Hexachlorobenzene | (4) | (5) | <1.80 | G |
| Hexachlorobutadiene | (4) | (5) | <10.00 | G |
| Hexachlorocyclopentadiene | (4) | (5) | <2.40 | G |
| Hexachloroethane | (4) | (5) | <3.70 | G |
| Indeno(1,2,3-cd)pyrene | 625 | 20.0 | <3.70 | G |
| Isophorone | 625 | 10.0 | <5.10 | G |
| Nitrobenzene | 625 | 10.0 | <4.20 | G |
| N-Nitrosodimethylamine | (4) | (5) | <6.20 | G |
| N-Nitrosodi-n-propylamine | (4) | (5) | <3.60 | G |
| N-Nitrosodiphenylamine | (4) | (5) | <2.70 | G |

| Outfall 004 Analytical Data for Water Quality Criteria Parameters | | | | |
|---|---|---|---|---|
| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL(1) | RESULT (ug/L) | SAMPLE TYPE(2) |
| Pyrene | 625 | 10.0 | <3.80 | G |
| 1,2,4-Trichlorobenzene | 625 | 10.0 | <7.90 | G |
| **VOLATILES** | | | | |
| Acrolein | (4) | (5) | <10.00 | G |
| Acrylonitrile | (4) | (5) | <1.50 | G |
| Benzene | 624 | 10.0 | <4.40 | G |
| Bromoform | 624 | 10.0 | <4.70 | G |
| Chlorobenzene (monochlorobenzene) | 624 | 50.0 | <6.00 | G |
| Chlorodibromomethane | 624 | 10.0 | <3.10 | G |
| Chloroform | 624 | 10.0 | <1.60 | G |
| Dichloromethane (methylene chloride) | 624 | 20.0 | <2.80 | G |
| Dichlorobromomethane | 624 | 10.0 | <2.20 | G |
| 1,2-Dichloroethane | 624 | 10.0 | <2.80 | G |
| 1,1-Dichloroethylene | 624 | 10.0 | <2.80 | G |
| 1,2-trans-dichloroethylene | (4) | (5) | <1.60 | G |
| 1,2-Dichloropropane | (4) | (5) | <6.00 | G |
| 1,3-Dichloropropene | (4) | (5) | <5.90 | G |
| Ethylbenzene | 624 | 10.0 | <7.20 | G |
| Methyl Bromide | (4) | (5) | <1.40 | G |
| 1,1,2,2-Tetrachloroethane | (4) | (5) | <6.90 | G |
| Tetrachloroethylene | 624 | 10.0 | <4.10 | G |
| Toluene | 624 | 10.0 | <6.00 | G |
| 1,1,2-Trichloroethane | (4) | (5) | <5.00 | G |
| Trichloroethylene | 624 | 10.0 | <1.90 | G |
| **RADIONUCLIDES** | | | | |
| Strontium 90 (pCi/L) | (4) | (5) | <0.498 | G |
| Tritium (pCi/L) | (4) | (5) | <247 | G |
| Beta Particle & Photon Activity (pCi/L) | (4) | (5) | <2.83 | G |

| Outfall 004 Analytical Data for Water Quality Criteria Parameters | | | | |
|---|---|---|---|---|
| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL(1) | RESULT (ug/L) | SAMPLE TYPE(2) |
| Gross Alpha Particle Activity (pCi/L) | (4) | (5) | 4.44 | G |
| ACIDS | | | | |
| 2-Chlorophenol | 625 | 10.0 | <3.30 | G |
| 2,4 Dichlorophenol | 625 | 10.0 | <5.60 | G |
| 2,4 Dimethylphenol | 625 | 10.0 | <5.20 | G |
| 2,4-Dinitrophenol | (4) | (5) | <42.00 | G |
| 2-Methyl-4,6-Dinitrophenol | (4) | (5) | <24.00 | G |
| Pentachlorophenol | 625 | 50.0 | <3.60 | G |
| Phenol | 625 | 10.0 | <2.70 | G |
| 2,4,6-Trichlorophenol | 625 | 10.0 | <2.70 | G |
| MISCELLANEOUS | | | | |
| Ammonia as NH3-N | 350.1 | 200 | 2,360 | G |
| Chlorides | (4) | (5) | 118,320 | G |
| Chlorine, Total Residual | (4) | 100 | < 100 | G |
| Cyanide, Total | (4) | 10.0 | <10.00 | G |
| *E. coli* / *Enterococcus* (N/CML) | (4) | (5) | <2.00 | G |
| Hydrogen Sulfide | (4) | (5) | <50.00 | G |
| Tributyltin (7) | NBSR 85-3295 | (5) | 0.032 | G |

A = Result is for total chromium

(1) Quantification level (QL) is defined as the lowest concentration used for the calibration of a measurement system when the calibration is in accordance with the procedures published for the required method.

The quantification levels indicated for the metals are actually Specific Target Values developed for this permit. The Specific Target Value is the approximate value that may initiate a wasteload allocation analysis. Target values are not wasteload allocations or effluent limitations. The Specific Target Values are subject to change based on additional information such as hardness data, receiving stream flow, and design flows.

Units for the quantification level are micrograms/liter unless otherwise specified.

Quality control and quality assurance information shall be submitted to document that the required quantification level has been attained.

(2) Sample Type

G = Grab = An individual sample collected in less than 15 minutes. Substances specified with "grab" sample type shall only be collected as grabs. The permittee may analyze multiple grabs and report the average results provided that the individual grab results are also reported. For grab metals samples, the individual samples shall be filtered and preserved immediately upon collection.

C = Composite = A 24-hour **(PW - Revise as required to require same composite duration as $BOD_5$)** composite unless otherwise specified. The composite shall be a combination of individual samples, taken proportional to flow, obtained at hourly or smaller time intervals. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period.

SC = Special Composite = samples for base/neutral/acid compounds, PCBs, and pesticides must be collected as 4 individual grab samples taken proportional to flow at 6-hour intervals over the course of one day. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period. Grab samples must be analyzed separately and the concentrations averaged. Alternately, grab samples may be collected in the field and composited in the laboratory if the compositing procedure produces results equivalent to results produced by arithmetic averaging of the results of analysis of individual grab samples.

(3) A specific analytical method is not specified; however a target value for each metal has been established. An appropriate method to meet the target value shall be selected from the following list of EPA methods (or any approved method presented in 40 CFR Part 136). If the test result is less than the method QL, a "<[QL]" shall be reported where the actual analytical test QL is substituted for [QL].

| Metal | Analytical Method |
|---|---|
| Antimony | 1638; 1639 |
| Arsenic | 206.5; 1632 |
| Chromium(9) | 1639 |
| Cadmium | 1637; 1638; 1639; 1640 |
| Chromium VI | 218.6; 1639 |
| Copper | 1638; 1640 |
| Lead | 1637; 1638; 1640 |
| Mercury | 245.7; 1631 |
| Nickel | 1638; 1639; 1640 |
| Selenium | 1638; 1639 |
| Silver | 1638 |
| Zinc | 1638; 1639 |

(4) Any approved method presented in 40 CFR Part 136.

(5) The QL is at the discretion of the permittee. For any substances addressed in 40 CFR Part 136, the permittee shall use one of the approved methods in 40 CFR Part 136.

(6) Testing for phenol requires continuous extraction.

(7) Analytical Methods: NBSR 85-3295 or DEQ's approved analysis for Tributyltin may also be used [See A Manual for the Analysis of Butyltins in Environmental Systems by the Virginia Institute of Marine Science, dated November 1996].

(8) Both Chromium III and Chromium VI may be measured by the total chromium analysis. If the result of the total chromium analysis is less than or equal to the lesser of the Chromium III or Chromium VI method QL, the results for both Chromium III and Chromium VI can be reported as "<[QL]", where the actual analytical test QL is substituted for [QL].

(9) The lab may use SW846 Method 8270D provided the lab has an Initial Demonstration of Capability, has passed a PT for Kepone, and meets the acceptance criteria for Kepone as given in Method 8270D

# Outfall 005 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL[1] | RESULT (ug/L) | SAMPLE TYPE[2] |
|---|---|---|---|---|
| **METALS** | | | | |
| Antimony, dissolved | (3) | 130,000 | <1.00 | G |
| Arsenic, dissolved | (3) | 2,800 | 5.00 | G |
| Cadmium, dissolved | (3) | 17 | <0.30 | G |
| Chromium III, dissolved [8] | (3) | 1,100 | <1.00[A] | G |
| Chromium VI, dissolved [8] | (3) | 200 | <10.00 | G |
| Copper, dissolved | (3) | 130 | <1.00 | G |
| Lead, dissolved | (3) | 180 | <1.00 | G |
| Mercury, dissolved | (3) | 1.6 | <0.20 | G |
| Nickel, dissolved | (3) | 300 | <5.00 | G |
| Selenium, dissolved | (3) | 93 | 4.00 | G |
| Silver, dissolved | (3) | 27 | <0.10 | G |
| Thallium, dissolved | (4) | 200 | 0.50 | G |
| Zinc, dissolved | (3) | 1,200 | <10.00 | G |
| **PESTICIDES / PCBs** | | | | |
| Aldrin | 608 | 0.05 | <0.016 | G |
| Chlordane | 608 | 0.2 | <0.014 | G |
| Chlorpyrifos (Dursban) | 622 | (5) | <0.014 | G |
| DDD | 608 | 0.1 | <0.021 | G |
| DDE | 608 | 0.1 | <0.017 | G |
| DDT | 608 | 0.1 | <0.017 | G |
| Demeton | (4) | (5) | <0.521 | G |
| Dieldrin | 608 | 0.1 | <0.010 | G |
| Alpha-Endosulfan | 608 | 0.1 | <0.014 | G |
| Beta-Endosulfan | 608 | 0.1 | <0.017 | G |
| Endosulfan Sulfate | 608 | 0.1 | <0.009 | G |
| Endrin | 608 | 0.1 | <0.020 | G |
| Endrin Aldehyde | (4) | (5) | <0.019 | G |

## Outfall 005 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL(1) | RESULT (ug/L) | SAMPLE TYPE(2) |
|---|---|---|---|---|
| Guthion | 622 | (5) | <0.3577 | G |
| Heptachlor | 608 | 0.05 | <0.016 | G |
| Heptachlor Epoxide | (4) | (5) | <0.012 | G |
| Hexachlorocyclohexane Alpha-BHC | 608 | (5) | <0.007 | G |
| Hexachlorocyclohexane Beta-BHC | 608 | (5) | <0.013 | G |
| HexachlorocyclohexaneGamma-BHC (Lindane) | 608 | (5) | <0.011 | G |
| Kepone | (9) | (5) | <0.015 | G |
| Malathion | (4) | (5) | <0.123 | G |
| Methoxychlor | (4) | (5) | <0.017 | G |
| Mirex | (4) | (5) | <0.015 | G |
| Parathion | (4) | (5) | <0.121 | G |
| PCB 1260 | 608 | 1.0 | <1.00 | G |
| PCB 1254 | 608 | 1.0 | <1.00 | G |
| PCB 1248 | 608 | 1.0 | <1.00 | G |
| PCB 1242 | 608 | 1.0 | <1.00 | G |
| PCB 1232 | 608 | 1.0 | <1.00 | G |
| PCB 1221 | 608 | 1.0 | <1.00 | G |
| PCB 1016 | 608 | 1.0 | <1.00 | G |
| PCB Total | 608 | 7.0 | <7.00 | G |
| Toxaphene | 608 | 5.0 | <0.057 | G |
| **BASE NEUTRALS** | | | | |
| Acenaphthene | 625 | 10.0 | <3.00 | G |
| Anthracene | 625 | 10.0 | <1.90 | G |
| Benzidine | (4) | (5) | <63.00 | G |
| Benzo (a) anthracene | 625 | 10.0 | <7.80 | G |
| Benzo (b) fluoranthene | 625 | 10.0 | <4.80 | G |
| Benzo (k) fluoranthene | 625 | 10.0 | <2.50 | G |
| Benzo (a) pyrene | 625 | 10.0 | <2.50 | G |

# Outfall 005 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL(1) | RESULT (ug/L) | SAMPLE TYPE(2) |
|---|---|---|---|---|
| Bis 2-Chloroethyl Ether | (4) | (5) | <5.70 | G |
| Bis 2-Chloroisopropyl Ether | (4) | (5) | <5.70 | G |
| Butyl benzyl phthalate | 625 | 10.0 | <2.50 | G |
| 2-Chloronaphthalene | (4) | (5) | <4.60 | G |
| Chrysene | 625 | 10.0 | <2.50 | G |
| Dibenz(a,h)anthracene | 625 | 20.0 | <2.50 | G |
| Dibutyl phthalate (Di-n-Butyl Phthalate) | 625 | 10.0 | <6.40 | G |
| 1,2-Dichlorobenzene | 624 | 10.0 | <4.00 | G |
| 1,3-Dichlorobenzene | 624 | 10.0 | <3.10 | G |
| 1,4-Dichlorobenzene | 624 | 10.0 | <4.40 | G |
| 3,3-Dichlorobenzidine | (4) | (5) | <16.50 | G |
| Diethyl phthalate | 625 | 10.0 | <7.40 | G |
| Di-2-Ethylhexyl Phthalate | 625 | 10.0 | <2.50 | G |
| Dimethyl phthalate | (4) | (5) | <7.50 | G |
| 2,4-Dinitrotoluene | 625 | 10.0 | <5.70 | G |
| 1,2-Diphenylhydrazine | (4) | (5) | <8.80 | G |
| Fluoranthene | 625 | 10.0 | <2.20 | G |
| Fluorene | 625 | 10.0 | <3.10 | G |
| Hexachlorobenzene | (4) | (5) | <1.80 | G |
| Hexachlorobutadiene | (4) | (5) | <10.00 | G |
| Hexachlorocyclopentadiene | (4) | (5) | <2.40 | G |
| Hexachloroethane | (4) | (5) | <3.70 | G |
| Indeno(1,2,3-cd)pyrene | 625 | 20.0 | <3.70 | G |
| Isophorone | 625 | 10.0 | <5.10 | G |
| Nitrobenzene | 625 | 10.0 | <4.20 | G |
| N-Nitrosodimethylamine | (4) | (5) | <6.20 | G |
| N-Nitrosodi-n-propylamine | (4) | (5) | <3.60 | G |
| N-Nitrosodiphenylamine | (4) | (5) | <2.70 | G |

# Outfall 005 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL[1] | RESULT (ug/L) | SAMPLE TYPE[2] |
|---|---|---|---|---|
| Pyrene | 625 | 10.0 | <3.80 | G |
| 1,2,4-Trichlorobenzene | 625 | 10.0 | <7.90 | G |
| **VOLATILES** | | | | |
| Acrolein | (4) | (5) | <10.00 | G |
| Acrylonitrile | (4) | (5) | <1.50 | G |
| Benzene | 624 | 10.0 | <4.40 | G |
| Bromoform | 624 | 10.0 | <4.70 | G |
| Chlorobenzene (monochlorobenzene) | 624 | 50.0 | <6.00 | G |
| Chlorodibromomethane | 624 | 10.0 | <3.10 | G |
| Chloroform | 624 | 10.0 | <1.60 | G |
| Dichloromethane (methylene chloride) | 624 | 20.0 | <2.80 | G |
| Dichlorobromomethane | 624 | 10.0 | <2.20 | G |
| 1,2-Dichloroethane | 624 | 10.0 | <2.80 | G |
| 1,1-Dichloroethylene | 624 | 10.0 | <2.80 | G |
| 1,2-trans-dichloroethylene | (4) | (5) | <1.60 | G |
| 1,2-Dichloropropane | (4) | (5) | <6.00 | G |
| 1,3-Dichloropropene | (4) | (5) | <5.90 | G |
| Ethylbenzene | 624 | 10.0 | <7.20 | G |
| Methyl Bromide | (4) | (5) | <1.40 | G |
| 1,1,2,2-Tetrachloroethane | (4) | (5) | <6.90 | G |
| Tetrachloroethylene | 624 | 10.0 | <4.10 | G |
| Toluene | 624 | 10.0 | <6.00 | G |
| 1,1,2-Trichloroethane | (4) | (5) | <5.00 | G |
| Trichloroethylene | 624 | 10.0 | <1.90 | G |
| **RADIONUCLIDES** | | | | |
| Strontium 90 (pCi/L) | (4) | (5) | <0.771 | G |
| Tritium (pCi/L) | (4) | (5) | 977 | G |
| Beta Particle & Photon Activity (pCi/L) | (4) | (5) | 2.88 | G |

## Outfall 005 Analytical Data for Water Quality Criteria Parameters

| CHEMICAL | EPA ANALYSIS NO. | QUANTIFICATION LEVEL(1) | RESULT (ug/L) | SAMPLE TYPE(2) |
|---|---|---|---|---|
| Gross Alpha Particle Activity (pCi/L) | (4) | (5) | <1.92 | G |
| **ACIDS** | | | | |
| 2-Chlorophenol | 625 | 10.0 | <3.30 | G |
| 2,4 Dichlorophenol | 625 | 10.0 | <5.60 | G |
| 2,4 Dimethylphenol | 625 | 10.0 | <5.20 | G |
| 2,4-Dinitrophenol | (4) | (5) | <42.00 | G |
| 2-Methyl-4,6-Dinitrophenol | (4) | (5) | <24.00 | G |
| Pentachlorophenol | 625 | 50.0 | <3.60 | G |
| Phenol | 625 | 10.0 | <2.70 | G |
| 2,4,6-Trichlorophenol | 625 | 10.0 | <2.70 | G |
| **MISCELLANEOUS** | | | | |
| Ammonia as NH3-N | 350.1 | 200 | 10.00 | G |
| Chlorides | (4) | (5) | 4,840 | G |
| Chlorine, Total Residual | (4) | 100 | < 100 | G |
| Cyanide, Total | (4) | 10.0 | <10.00 | G |
| *E. coli* / *Enterococcus* (N/CML) | (4) | (5) | <2.00 | G |
| Hydrogen Sulfide | (4) | (5) | <50.00 | G |
| Tributyltin (7) | NBSR 85-3295 | (5) | 0.030 | G |

A = Result is for total chromium

(1) Quantification level (QL) is defined as the lowest concentration used for the calibration of a measurement system when the calibration is in accordance with the procedures published for the required method.

The quantification levels indicated for the metals are actually Specific Target Values developed for this permit. The Specific Target Value is the approximate value that may initiate a wasteload allocation analysis. Target values are not wasteload allocations or effluent limitations. The Specific Target Values are subject to change based on additional information such as hardness data, receiving stream flow, and design flows.

Units for the quantification level are micrograms/liter unless otherwise specified.

Quality control and quality assurance information shall be submitted to document that the required quantification level has been attained.

(2) Sample Type

G = Grab = An individual sample collected in less than 15 minutes. Substances specified with "grab" sample type shall only be collected as grabs. The permittee may analyze multiple grabs and report the average results provided that the individual grab results are also reported. For grab metals samples, the individual samples shall be filtered and preserved immediately upon collection.

C = Composite = A 24-hour **(PW - Revise as required to require same composite duration as $BOD_5$)** composite unless otherwise specified. The composite shall be a combination of individual samples, taken proportional to flow, obtained at hourly or smaller time intervals. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period.

SC = Special Composite = samples for base/neutral/acid compounds, PCBs, and pesticides must be collected as 4 individual grab samples taken proportional to flow at 6-hour intervals over the course of one day. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period. Grab samples must be analyzed separately and the concentrations averaged. Alternately, grab samples may be collected in the field and composited in the laboratory if the compositing procedure produces results equivalent to results produced by arithmetic averaging of the results of analysis of individual grab samples.

(3) A specific analytical method is not specified; however a target value for each metal has been established. An appropriate method to meet the target value shall be selected from the following list of EPA methods (or any approved method presented in 40 CFR Part 136). If the test result is less than the method QL, a "<[QL]" shall be reported where the actual analytical test QL is substituted for [QL].

| Metal | Analytical Method |
|---|---|
| Antimony | 1638; 1639 |
| Arsenic | 206.5; 1632 |
| Chromium(9) | 1639 |
| Cadmium | 1637; 1638; 1639; 1640 |
| Chromium VI | 218.6; 1639 |
| Copper | 1638; 1640 |
| Lead | 1637; 1638; 1640 |
| Mercury | 245.7; 1631 |
| Nickel | 1638; 1639; 1640 |
| Selenium | 1638; 1639 |
| Silver | 1638 |
| Zinc | 1638; 1639 |

(4) Any approved method presented in 40 CFR Part 136.

(5) The QL is at the discretion of the permittee. For any substances addressed in 40 CFR Part 136, the permittee shall use one of the approved methods in 40 CFR Part 136.

(6) Testing for phenol requires continuous extraction.

(7) Analytical Methods: NBSR 85-3295 or DEQ's approved analysis for Tributyltin may also be used [See A Manual for the Analysis of Butyltins in Environmental Systems by the Virginia Institute of Marine Science, dated November 1996].

(8) Both Chromium III and Chromium VI may be measured by the total chromium analysis. If the result of the total chromium analysis is less than or equal to the lesser of the Chromium III or Chromium VI method QL, the results for both Chromium III and Chromium VI can be reported as "<[QL]", where the actual analytical test QL is substituted for [QL].

(9) The lab may use SW846 Method 8270D provided the lab has an Initial Demonstration of Capability, has passed a PT for Kepone, and meets the acceptance criteria for Kepone as given in Method 8270D .

## Attachment 5

Effluent Limitation Development:

a. Reasonable Potential Analyses for Outfalls 001 and 002
b. Reasonable Potential Analyses for Outfall 003
c. Reasonable Potential Analyses for Outfalls 004 and 005
d. Ammonia
e. Total Phosphorus
f. Modeling Associated with SCR addition
g. 40 CFR 423

a. Reasonable Potential Analysis for Outfalls 001 and 002

Effluent limitations for parameters submitted with the application were evaluated in accordance with DEQ Guidance Memo 00-2011. All observed pollutants and pollutants reported as less than QLs that exceeded the agency accepted values were evaluated for reasonable potential to violate in stream water quality standards. Pollutants that were reported as less than a DEQ accepted QL were considered absent for the purposes of this evaluation.

MSTRANTI (version 2b), a DEQ developed spreadsheet was used to calculate Waste Load Allocations (WLAs) based on mixed conditions. Stream data, effluent data and mixing ratios were entered into MSTRANTI to determine the WLAs.

Outfalls 001 and 002 discharge to the tidal James River. Because of the challenge in modeling tidal discharges, default dilution ratios of 2:1 acute and 50:1 chronic were assumed. Mixing ratios were input in MSTRANTI as follows:

2:1 acute → A design flow of 1 MGD and 1Q10 flow of 1 MGD

50:1 chronic → A design flow of 1 MGD and 7Q10 flow of 49 MGD

STATS.EXE (version 2.0.4) was then used to evaluate reasonable potential and calculate limitations if needed. WLAs, monitoring frequencies and reported effluent pollutant concentrations were input in STATS.EXE to evaluate each pollutant individually. Because chlorine is purposefully introduced in to the effluent, TRC limitations were forced using an assumed datum. As shown in the STATS outputs included in this section, no other limitations are needed to protect ambient aquatic Water Quality Standards at Outfalls 001 and 002.

For parameters with standards based on Human Health (HH), the maximum observed values were compared to the HH WLAs calculated in MSTRANTI. The receiving stream is not designated as a PWS, so the HH PWS standards do not apply to this discharge. However, the PWS WLAs were calculated for illustrative purposes. As shown in the table below, all of the observed values were substantially less than the WLAs; therefore, no limitations are needed for these parameters to protect human health.

In the application, the values reported for Beta Particle and Photon Activity are in units of activity (i.e. pCi/L) whereas the applicable water quality standard is an exposure in terms of mrem/yr. The EPA has established this same standard for community potable water systems. EPA guidance states that compliance with the potable water standard may be assumed if the average annual concentration of Beta Particle and Photon Activity is less than 50 pCi/L (**Radionuclides in Drinking Water: A Small Entity Compliance Guide.** EPA 815-R-02-001, February 2002.; http://www.epa.gov/safewater/radionuclides/compliancehelp.html). Consequently, the reported concentration of Beta Particle and Photon Activity is considered to meet the applicable water quality standards. Pollutants without an applicable standard cannot be evaluated at this time.

| Pollutant | Observed Value | | Human Health WLA | | Reasonable Potential (Y/N) |
|---|---|---|---|---|---|
| | Outfall 001 | Outfall 002 | PWS | All Other Waters | |
| Dissolved Copper (µg/L) | 6.00, <1.0 | 13.00, 4.00 | 65000 | | N |
| Dissolved Zinc (µg/L) | 13.00 | 26.00 | 370000 | 1300000 | N |
| Chloroform (µg/L) | 1.88 | 1.60 | 17000 | 550000 | N |
| Beta Particle & Photon Activity (pCi/L) | 3.69 | | 200 mrem/year | | N |
| Chlorides (µg/L) | 30440 | 32010 | 13000000 | | N |
| Dissolved Barium (µg/L) | 105 | 100 | 100000 | | N |

| Pollutant | Observed Value | | Human Health WLA | | Reasonable Potential (Y/N) |
|---|---|---|---|---|---|
| | Outfall 001 | Outfall 002 | PWS | All Other Waters | |
| Dissolved Iron (µg/L) | 700 | 500 | 15000 | | N |
| Dissolved Manganese (µg/L) | 60 | 50 | 2500 | | N |
| Sulfate (mg/L) | 54.52 | 55.82 | 13000 | | N |
| E. coli (N/100mL) | 50 | 30 | 126 | 126 | N |

* Observed values are expressed in terms of total rather than dissolved.

# MSTRANTI DATA SOURCE REPORT

(Chesterfield Power Station: Outfalls 001 & 002)

| | |
|---|---|
| **Stream Information** | |
| Mean Hardness | 2-JMS099.30 |
| 90% Temperature (annual) | 2-JMS099.30 |
| 90% Temperature (wet season) | NA |
| 90% Maximum pH | 2-JMS099.30 |
| 10% Maximum pH | 2-JMS099.30 |
| Tier Designation | Flow Frequency Memo (11/4/11) |
| **Stream Flows & Mixing Information** | |
| All Data | Tidal Default Mixing Ratios |
| **Effluent Information** | |
| Mean Hardness | App Data (002 mean hardness, which is less than the 001 mean hardness and therefore a more conservative value.) |
| 90% Temperature (annual) | The 90% max temperature for Outfall 002, which is higher than 90% max temperature from Outfall 001. |
| 90% Temperature (wet season) | NA |
| 90% Maximum pH | The ambient stream pH based on 40 years of sampling was used in lieu of the single effluent sample provided in the application. Because the effluent is non-contact cooling water withdrawn from the river and there is no chemical adjustment of pH, the stream values are considered a more conservative input. In addition, the single sample effluent value is within the ambient range. |
| 10% Maximum pH | |
| Discharge Flow | Tidal Default Mixing Ratios |

Data Location:

Flow Frequency Analysis – Attachment 3
DMR Data – Attachment 4
App Data – Attachment 4

# FRESHWATER
# WATER QUALITY CRITERIA / WASTELOAD ALLOCATION ANALYSIS

Facility Name: Dominion Chesterfield Power Station (001-002)    Permit No.: VA0004146

Receiving Stream: James River    Version: OWP Guidance Memo 00-2011 (8/24/00)

| Stream Information | | |
|---|---|---|
| Mean Hardness (as CaCO3) = | 66 | mg/L |
| 90% Temperature (Annual) = | 29.3 | deg C |
| 90% Temperature (Wet season) = | NA | deg C |
| 90% Maximum pH = | 7.9 | SU |
| 10% Maximum pH = | 7.1 | SU |
| Tier Designation (1 or 2) = | 1 | |
| Public Water Supply (PWS) Y/N? = | y | |
| Trout Present Y/N? = | n | |
| Early Life Stages Present Y/N? = | y | |

| Stream Flows | | |
|---|---|---|
| 1Q10 (Annual) = | 1 | MGD |
| 7Q10 (Annual) = | 49 | MGD |
| 30Q10 (Annual) = | 49 | MGD |
| 1Q10 (Wet season) = | na | MGD |
| 30Q10 (Wet season) | na | MGD |
| 30Q5 = | 49 | MGD |
| Harmonic Mean = | 49 | MGD |

| Mixing Information | | |
|---|---|---|
| Annual - 1Q10 Mix = | 100 | % |
| - 7Q10 Mix = | 100 | % |
| - 30Q10 Mix = | 100 | % |
| Wet Season - 1Q10 Mix = | 100 | % |
| - 30Q10 Mix = | 100 | % |

| Effluent Information | | |
|---|---|---|
| Mean Hardness (as CaCO3) = | 88 | mg/L |
| 90% Temp (Annual) = | 50.2 | deg C |
| 90% Temp (Wet season) = | na | deg C |
| 90% Maximum pH = | 7.9 | SU |
| 10% Maximum pH = | 7.1 | SU |
| Discharge Flow = | 1 | MGD |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | **Most Limiting Allocations** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | **Acute** | **Chronic** | **HH (PWS)** | **HH** |
| Acenapthene | 5 | -- | -- | 6.7E+02 | 9.9E+02 | -- | -- | 3.3E+04 | 4.9E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.3E+04** | **4.9E+04** |
| Acrolein | 0 | -- | -- | 6.1E+00 | 9.3E+00 | -- | -- | 3.1E+02 | 4.7E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.1E+02** | **4.7E+02** |
| Acrylonitrile$^{C}$ | 0 | -- | -- | 5.1E-01 | 2.5E+00 | -- | -- | 2.6E+01 | 1.3E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.6E+01** | **1.3E+02** |
| Aldrin $^{C}$ | 0 | 3.0E+00 | -- | 4.9E-04 | 5.0E-04 | 6.0E+00 | -- | 2.5E-02 | 2.5E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **6.0E+00** | **--** | **2.5E-02** | **2.5E-02** |
| Ammonia-N (mg/l) (Yearly) | 0 | 1.01E+01 | 1.05E+00 | -- | -- | 2.03E+01 | 5.25E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **2.03E+01** | **5.25E+01** | **--** | **--** |
| Ammonia-N (mg/l) (High Flow) | 0 | #VALUE! | #VALUE! | -- | -- | #VALUE! | #VALUE! | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **#VALUE!** | **#VALUE!** | **--** | **--** |
| Anthracene | 0 | -- | -- | 8.3E+03 | 4.0E+04 | -- | -- | 4.2E+05 | 2.0E+06 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.2E+05** | **2.0E+06** |
| Antimony | 0 | -- | -- | 5.6E+00 | 6.4E+02 | -- | -- | 2.8E+02 | 3.2E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.8E+02** | **3.2E+04** |
| Arsenic | o | 3.4E+02 | 1.5E+02 | 1.0E+01 | -- | 6.8E+02 | 7.5E+03 | 5.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **6.8E+02** | **7.5E+03** | **5.0E+02** | **--** |
| Barium | 0 | -- | -- | 2.0E+03 | -- | -- | -- | 1.0E+05 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+05** | **--** |
| Benzene $^{C}$ | 0 | -- | -- | 2.2E+01 | 5.1E+02 | -- | -- | 1.1E+03 | 2.6E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.1E+03** | **2.6E+04** |
| Benzidine$^{C}$ | 0 | -- | -- | 8.6E-04 | 2.0E-03 | -- | -- | 4.3E-02 | 1.0E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.3E-02** | **1.0E-01** |
| Benzo (a) anthracene $^{C}$ | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 1.9E+00 | 9.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.9E+00** | **9.0E+00** |
| Benzo (b) fluoranthene $^{C}$ | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 1.9E+00 | 9.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.9E+00** | **9.0E+00** |
| Benzo (k) fluoranthene $^{C}$ | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 1.9E+00 | 9.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.9E+00** | **9.0E+00** |
| Benzo (a) pyrene $^{C}$ | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 1.9E+00 | 9.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.9E+00** | **9.0E+00** |
| Bis2-Chloroethyl Ether $^{C}$ | 0 | -- | -- | 3.0E-01 | 5.3E+00 | -- | -- | 1.5E+01 | 2.7E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.5E+01** | **2.7E+02** |
| Bis2-Chloroisopropyl Ether | 0 | -- | -- | 1.4E+03 | 6.5E+04 | -- | -- | 7.0E+04 | 3.3E+06 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.0E+04** | **3.3E+06** |
| Bis 2-Ethylhexyl Phthalate $^{C}$ | 0 | -- | -- | 1.2E+01 | 2.2E+01 | -- | -- | 6.0E+02 | 1.1E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.0E+02** | **1.1E+03** |
| Bromoform $^{C}$ | 0 | -- | -- | 4.3E+01 | 1.4E+03 | -- | -- | 2.2E+03 | 7.0E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.2E+03** | **7.0E+04** |
| Butylbenzylphthalate | 0 | -- | -- | 1.5E+03 | 1.9E+03 | -- | -- | 7.5E+04 | 9.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.5E+04** | **9.5E+04** |
| Cadmium | 0 | 2.9E+00 | 8.2E-01 | 5.0E+00 | -- | 5.8E+00 | 4.1E+01 | 2.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **5.8E+00** | **4.1E+01** | **2.5E+02** | **--** |
| Carbon Tetrachloride $^{C}$ | 0 | -- | -- | 2.3E+00 | 1.6E+01 | -- | -- | 1.2E+02 | 8.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.2E+02** | **8.0E+02** |
| Chlordane $^{C}$ | 0 | 2.4E+00 | 4.3E-03 | 8.0E-03 | 8.1E-03 | 4.8E+00 | 2.2E-01 | 4.0E-01 | 4.1E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **4.8E+00** | **2.2E-01** | **4.0E-01** | **4.1E-01** |
| Chloride | 0 | 8.6E+05 | 2.3E+05 | 2.5E+05 | -- | 1.7E+06 | 1.2E+07 | 1.3E+07 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.7E+06** | **1.2E+07** | **1.3E+07** | **--** |
| TRC | 0 | 1.9E+01 | 1.1E+01 | -- | -- | 3.8E+01 | 5.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **3.8E+01** | **5.5E+02** | **--** | **--** |
| Chlorobenzene | 0 | -- | -- | 1.3E+02 | 1.6E+03 | -- | -- | 6.5E+03 | 8.0E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.5E+03** | **8.0E+04** |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | **Most Limiting Allocations** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | **Acute** | **Chronic** | **HH (PWS)** | **HH** |
| Chlorodibromomethane[C] | 0 | -- | -- | 4.0E+00 | 1.3E+02 | -- | -- | 2.0E+02 | 6.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.0E+02** | **6.5E+03** |
| Chloroform | 0 | -- | -- | 3.4E+02 | 1.1E+04 | -- | -- | 1.7E+04 | 5.5E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.7E+04** | **5.5E+05** |
| 2-Chloronaphthalene | 0 | -- | -- | 1.0E+03 | 1.6E+03 | -- | -- | 5.0E+04 | 8.0E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E+04** | **8.0E+04** |
| 2-Chlorophenol | 0 | -- | -- | 8.1E+01 | 1.5E+02 | -- | -- | 4.1E+03 | 7.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.1E+03** | **7.5E+03** |
| Chlorpyrifos | 0 | 8.3E-02 | 4.1E-02 | -- | -- | 1.7E-01 | 2.1E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.7E-01** | **2.1E+00** | **--** | **--** |
| Chromium III | 0 | 4.6E+02 | 5.3E+01 | -- | -- | 9.2E+02 | 2.7E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **9.2E+02** | **2.7E+03** | **--** | **--** |
| Chromium VI | 0 | 1.6E+01 | 1.1E+01 | -- | -- | 3.2E+01 | 5.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **3.2E+01** | **5.5E+02** | **--** | **--** |
| Chromium, Total | 0 | -- | -- | 1.0E+02 | -- | -- | -- | 5.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E+03** | **--** |
| Chrysene [C] | 0 | -- | -- | 3.8E-03 | 1.8E-02 | -- | -- | 1.9E-01 | 9.0E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.9E-01** | **9.0E-01** |
| Copper | 0 | 1.1E+01 | 6.3E+00 | 1.3E+03 | -- | 2.1E+01 | 3.2E+02 | 6.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **2.1E+01** | **3.2E+02** | **6.5E+04** | **--** |
| Cyanide, Free | 0 | 2.2E+01 | 5.2E+00 | 1.4E+02 | 1.6E+04 | 4.4E+01 | 2.6E+02 | 7.0E+03 | 8.0E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **4.4E+01** | **2.6E+02** | **7.0E+03** | **8.0E+05** |
| DDD [C] | 0 | -- | -- | 3.1E-03 | 3.1E-03 | -- | -- | 1.6E-01 | 1.6E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.6E-01** | **1.6E-01** |
| DDE [C] | 0 | -- | -- | 2.2E-03 | 2.2E-03 | -- | -- | 1.1E-01 | 1.1E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.1E-01** | **1.1E-01** |
| DDT [C] | 0 | 1.1E+00 | 1.0E-03 | 2.2E-03 | 2.2E-03 | 2.2E+00 | 5.0E-02 | 1.1E-01 | 1.1E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **2.2E+00** | **5.0E-02** | **1.1E-01** | **1.1E-01** |
| Demeton | 0 | -- | 1.0E-01 | -- | -- | -- | 5.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **5.0E+00** | **--** | **--** |
| Diazinon | 0 | 1.7E-01 | 1.7E-01 | -- | -- | 3.4E-01 | 8.5E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **3.4E-01** | **8.5E+00** | **--** | **--** |
| Dibenz(a,h)anthracene [C] | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 1.9E+00 | 9.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.9E+00** | **9.0E+00** |
| 1,2-Dichlorobenzene | 0 | -- | -- | 4.2E+02 | 1.3E+03 | -- | -- | 2.1E+04 | 6.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.1E+04** | **6.5E+04** |
| 1,3-Dichlorobenzene | 0 | -- | -- | 3.2E+02 | 9.6E+02 | -- | -- | 1.6E+04 | 4.8E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.6E+04** | **4.8E+04** |
| 1,4-Dichlorobenzene | 0 | -- | -- | 6.3E+01 | 1.9E+02 | -- | -- | 3.2E+03 | 9.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.2E+03** | **9.5E+03** |
| 3,3-Dichlorobenzidine[C] | 0 | -- | -- | 2.1E-01 | 2.8E-01 | -- | -- | 1.1E+01 | 1.4E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.1E+01** | **1.4E+01** |
| Dichlorobromomethane [C] | 0 | -- | -- | 5.5E+00 | 1.7E+02 | -- | -- | 2.8E+02 | 8.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.8E+02** | **8.5E+03** |
| 1,2-Dichloroethane [C] | 0 | -- | -- | 3.8E+00 | 3.7E+02 | -- | -- | 1.9E+02 | 1.9E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.9E+02** | **1.9E+04** |
| 1,1-Dichloroethylene | 0 | -- | -- | 3.3E+02 | 7.1E+03 | -- | -- | 1.7E+04 | 3.6E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.7E+04** | **3.6E+05** |
| 1,2-trans-dichloroethylene | 0 | -- | -- | 1.4E+02 | 1.0E+04 | -- | -- | 7.0E+03 | 5.0E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.0E+03** | **5.0E+05** |
| 2,4-Dichlorophenol | 0 | -- | -- | 7.7E+01 | 2.9E+02 | -- | -- | 3.9E+03 | 1.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.9E+03** | **1.5E+04** |
| 2,4-Dichlorophenoxy acetic acid (2,4-D) | 0 | -- | -- | 1.0E+02 | -- | -- | -- | 5.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E+03** | **--** |
| 1,2-Dichloropropane[C] | 0 | -- | -- | 5.0E+00 | 1.5E+02 | -- | -- | 2.5E+02 | 7.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.5E+02** | **7.5E+03** |
| 1,3-Dichloropropene [C] | 0 | -- | -- | 3.4E+00 | 2.1E+02 | -- | -- | 1.7E+02 | 1.1E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.7E+02** | **1.1E+04** |
| Dieldrin [C] | 0 | 2.4E-01 | 5.6E-02 | 5.2E-04 | 5.4E-04 | 4.8E-01 | 2.8E+00 | 2.6E-02 | 2.7E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **4.8E-01** | **2.8E+00** | **2.6E-02** | **2.7E-02** |
| Diethyl Phthalate | 0 | -- | -- | 1.7E+04 | 4.4E+04 | -- | -- | 8.5E+05 | 2.2E+06 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **8.5E+05** | **2.2E+06** |
| 2,4-Dimethylphenol | 0 | -- | -- | 3.8E+02 | 8.5E+02 | -- | -- | 1.9E+04 | 4.3E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.9E+04** | **4.3E+04** |
| Dimethyl Phthalate | 0 | -- | -- | 2.7E+05 | 1.1E+06 | -- | -- | 1.4E+07 | 5.5E+07 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.4E+07** | **5.5E+07** |
| Di-n-Butyl Phthalate | 0 | -- | -- | 2.0E+03 | 4.5E+03 | -- | -- | 1.0E+05 | 2.3E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+05** | **2.3E+05** |
| 2,4 Dinitrophenol | 0 | -- | -- | 6.9E+01 | 5.3E+03 | -- | -- | 3.5E+03 | 2.7E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.5E+03** | **2.7E+05** |
| 2-Methyl-4,6-Dinitrophenol | 0 | -- | -- | 1.3E+01 | 2.8E+02 | -- | -- | 6.5E+02 | 1.4E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.5E+02** | **1.4E+04** |
| 2,4-Dinitrotoluene [C] | 0 | -- | -- | 1.1E+00 | 3.4E+01 | -- | -- | 5.5E+01 | 1.7E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.5E+01** | **1.7E+03** |
| Dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin | 0 | -- | -- | 5.0E-08 | 5.1E-08 | -- | -- | 2.5E-06 | 2.6E-06 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.5E-06** | **2.6E-06** |
| 1,2-Diphenylhydrazine[C] | 0 | -- | -- | 3.6E-01 | 2.0E+00 | -- | -- | 1.8E+01 | 1.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.8E+01** | **1.0E+02** |
| Alpha-Endosulfan | 0 | 2.2E-01 | 5.6E-02 | 6.2E+01 | 8.9E+01 | 4.4E-01 | 2.8E+00 | 3.1E+03 | 4.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **4.4E-01** | **2.8E+00** | **3.1E+03** | **4.5E+03** |
| Beta-Endosulfan | 0 | 2.2E-01 | 5.6E-02 | 6.2E+01 | 8.9E+01 | 4.4E-01 | 2.8E+00 | 3.1E+03 | 4.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **4.4E-01** | **2.8E+00** | **3.1E+03** | **4.5E+03** |
| Alpha + Beta Endosulfan | 0 | 2.2E-01 | 5.6E-02 | -- | -- | 4.4E-01 | 2.8E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **4.4E-01** | **2.8E+00** | **--** | **--** |
| Endosulfan Sulfate | 0 | -- | -- | 6.2E+01 | 8.9E+01 | -- | -- | 3.1E+03 | 4.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.1E+03** | **4.5E+03** |
| Endrin | 0 | 8.6E-02 | 3.6E-02 | 5.9E-02 | 6.0E-02 | 1.7E-01 | 1.8E+00 | 3.0E+00 | 3.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **1.7E-01** | **1.8E+00** | **3.0E+00** | **3.0E+00** |
| Endrin Aldehyde | 0 | -- | -- | 2.9E-01 | 3.0E-01 | -- | -- | 1.5E+01 | 1.5E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.5E+01** | **1.5E+01** |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | **Most Limiting Allocations** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | **Acute** | **Chronic** | **HH (PWS)** | **HH** |
| Ethylbenzene | 0 | -- | -- | 5.3E+02 | 2.1E+03 | -- | -- | 2.7E+04 | 1.1E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.7E+04** | **1.1E+05** |
| Fluoranthene | 0 | -- | -- | 1.3E+02 | 1.4E+02 | -- | -- | 6.5E+03 | 7.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.5E+03** | **7.0E+03** |
| Fluorene | 0 | -- | -- | 1.1E+03 | 5.3E+03 | -- | -- | 5.5E+04 | 2.7E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.5E+04** | **2.7E+05** |
| Foaming Agents | 0 | -- | -- | 5.0E+02 | -- | -- | -- | 2.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.5E+04** | **--** |
| Guthion | 0 | -- | 1.0E-02 | -- | -- | -- | 5.0E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **5.0E-01** | **--** | **--** |
| Heptachlor [C] | 0 | 5.2E-01 | 3.8E-03 | 7.9E-04 | 7.9E-04 | 1.0E+00 | 1.9E-01 | 4.0E-02 | 4.0E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **1.0E+00** | **1.9E-01** | **4.0E-02** | **4.0E-02** |
| Heptachlor Epoxide[C] | 0 | 5.2E-01 | 3.8E-03 | 3.9E-04 | 3.9E-04 | 1.0E+00 | 1.9E-01 | 2.0E-02 | 2.0E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **1.0E+00** | **1.9E-01** | **2.0E-02** | **2.0E-02** |
| Hexachlorobenzene[C] | 0 | -- | -- | 2.8E-03 | 2.9E-03 | -- | -- | 1.4E-01 | 1.5E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.4E-01** | **1.5E-01** |
| Hexachlorobutadiene[C] | 0 | -- | -- | 4.4E+00 | 1.8E+02 | -- | -- | 2.2E+02 | 9.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.2E+02** | **9.0E+03** |
| Hexachlorocyclohexane Alpha-BHC[C] | 0 | -- | -- | 2.6E-02 | 4.9E-02 | -- | -- | 1.3E+00 | 2.5E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+00** | **2.5E+00** |
| Hexachlorocyclohexane Beta-BHC[C] | 0 | -- | -- | 9.1E-02 | 1.7E-01 | -- | -- | 4.6E+00 | 8.5E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.6E+00** | **8.5E+00** |
| Hexachlorocyclohexane Gamma-BHC[C] (Lindane) | 0 | 9.5E-01 | -- | 9.8E-01 | 1.8E+00 | 1.9E+00 | -- | 4.9E+01 | 9.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **1.9E+00** | **--** | **4.9E+01** | **9.0E+01** |
| Hexachlorocyclopentadiene | 0 | -- | -- | 4.0E+01 | 1.1E+03 | -- | -- | 2.0E+03 | 5.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.0E+03** | **5.5E+04** |
| Hexachloroethane[C] | 0 | -- | -- | 1.4E+01 | 3.3E+01 | -- | -- | 7.0E+02 | 1.7E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.0E+02** | **1.7E+03** |
| Hydrogen Sulfide | 0 | -- | 2.0E+00 | -- | -- | -- | 1.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **1.0E+02** | **--** | **--** |
| Indeno (1,2,3-cd) pyrene [C] | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 1.9E+00 | 9.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.9E+00** | **9.0E+00** |
| Iron | 0 | -- | -- | 3.0E+02 | -- | -- | -- | 1.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.5E+04** | **--** |
| Isophorone[C] | 0 | -- | -- | 3.5E+02 | 9.6E+03 | -- | -- | 1.8E+04 | 4.8E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.8E+04** | **4.8E+05** |
| Kepone | 0 | -- | 0.0E+00 | -- | -- | -- | 0.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **0.0E+00** | **--** | **--** |
| Lead | 0 | 8.5E+01 | 8.0E+00 | 1.5E+01 | -- | 1.7E+02 | 4.0E+02 | 7.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.7E+02** | **4.0E+02** | **7.5E+02** | **--** |
| Malathion | 0 | -- | 1.0E-01 | -- | -- | -- | 5.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **5.0E+00** | **--** | **--** |
| Manganese | 0 | -- | -- | 5.0E+01 | -- | -- | -- | 2.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.5E+03** | **--** |
| Mercury | 0 | 1.4E+00 | 7.7E-01 | - - | - - | 2.8E+00 | 3.9E+01 | - - | - - | -- | -- | -- | -- | -- | -- | -- | -- | **2.8E+00** | **3.9E+01** | **- -** | **- -** |
| Methyl Bromide | 0 | -- | -- | 4.7E+01 | 1.5E+03 | -- | -- | 2.4E+03 | 7.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.4E+03** | **7.5E+04** |
| Methylene Chloride [C] | 0 | -- | -- | 4.6E+01 | 5.9E+03 | -- | -- | 2.3E+03 | 3.0E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.3E+03** | **3.0E+05** |
| Methoxychlor | 0 | -- | 3.0E-02 | 1.0E+02 | -- | -- | 1.5E+00 | 5.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **1.5E+00** | **5.0E+03** | **--** |
| Mirex | 0 | -- | 0.0E+00 | -- | -- | -- | 0.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **0.0E+00** | **--** | **--** |
| Nickel | 0 | 1.5E+02 | 1.4E+01 | 6.1E+02 | 4.6E+03 | 2.9E+02 | 7.2E+02 | 3.1E+04 | 2.3E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **2.9E+02** | **7.2E+02** | **3.1E+04** | **2.3E+05** |
| Nitrate (as N) | 0 | -- | -- | 1.0E+04 | -- | -- | -- | 5.0E+05 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E+05** | **--** |
| Nitrobenzene | 0 | -- | -- | 1.7E+01 | 6.9E+02 | -- | -- | 8.5E+02 | 3.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **8.5E+02** | **3.5E+04** |
| N-Nitrosodimethylamine[C] | 0 | -- | -- | 6.9E-03 | 3.0E+01 | -- | -- | 3.5E-01 | 1.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.5E-01** | **1.5E+03** |
| N-Nitrosodiphenylamine[C] | 0 | -- | -- | 3.3E+01 | 6.0E+01 | -- | -- | 1.7E+03 | 3.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.7E+03** | **3.0E+03** |
| N-Nitrosodi-n-propylamine[C] | 0 | -- | -- | 5.0E-02 | 5.1E+00 | -- | -- | 2.5E+00 | 2.6E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.5E+00** | **2.6E+02** |
| Nonylphenol | 0 | 2.8E+01 | 6.6E+00 | -- | -- | 5.6E+01 | 3.3E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **5.6E+01** | **3.3E+02** | **--** | **--** |
| Parathion | 0 | 6.5E-02 | 1.3E-02 | -- | -- | 1.3E-01 | 6.5E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.3E-01** | **6.5E-01** | **--** | **--** |
| PCB Total[C] | 0 | -- | 1.4E-02 | 6.4E-04 | 6.4E-04 | -- | 7.0E-01 | 3.2E-02 | 3.2E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **7.0E-01** | **3.2E-02** | **3.2E-02** |
| Pentachlorophenol [C] | 0 | 9.6E+00 | 7.4E+00 | 2.7E+00 | 3.0E+01 | 1.9E+01 | 3.7E+02 | 1.4E+02 | 1.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **1.9E+01** | **3.7E+02** | **1.4E+02** | **1.5E+03** |
| Phenol | 0 | -- | -- | 1.0E+04 | 8.6E+05 | -- | -- | 5.0E+05 | 4.3E+07 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E+05** | **4.3E+07** |
| Pyrene | 0 | -- | -- | 8.3E+02 | 4.0E+03 | -- | -- | 4.2E+04 | 2.0E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.2E+04** | **2.0E+05** |
| Radionuclides | 0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **--** | **--** |
| Gross Alpha Activity (pCi/L) | 0 | -- | -- | 1.5E+01 | -- | -- | -- | 7.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.5E+02** | **--** |
| Beta and Photon Activity (mrem/yr) | 0 | -- | -- | 4.0E+00 | -- | -- | -- | 2.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.0E+02** | **--** |
| Radium 226 + 228 (pCi/L) | 0 | -- | -- | 5.0E+00 | -- | -- | -- | 2.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.5E+02** | **--** |
| Uranium (ug/l) | 0 | -- | -- | 3.0E+01 | -- | -- | -- | 1.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.5E+03** | **--** |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | **Most Limiting Allocations** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | **Acute** | **Chronic** | **HH (PWS)** | **HH** |
| Selenium, Total Recoverable | 0 | 2.0E+01 | 5.0E+00 | 1.7E+02 | 4.2E+03 | 4.0E+01 | 2.5E+02 | 8.5E+03 | 2.1E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **4.0E+01** | **2.5E+02** | **8.5E+03** | **2.1E+05** |
| Silver | 0 | 2.2E+00 | -- | -- | -- | 4.4E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **4.4E+00** | **--** | **--** | **--** |
| Sulfate | 0 | -- | -- | 2.5E+05 | -- | -- | -- | 1.3E+07 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+07** | **--** |
| 1,1,2,2-Tetrachloroethane[C] | 0 | -- | -- | 1.7E+00 | 4.0E+01 | -- | -- | 8.5E+01 | 2.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **8.5E+01** | **2.0E+03** |
| Tetrachloroethylene[C] | 0 | -- | -- | 6.9E+00 | 3.3E+01 | -- | -- | 3.5E+02 | 1.7E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.5E+02** | **1.7E+03** |
| Thallium | 0 | -- | -- | 2.4E-01 | 4.7E-01 | -- | -- | 1.2E+01 | 2.4E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.2E+01** | **2.4E+01** |
| Toluene | 0 | -- | -- | 5.1E+02 | 6.0E+03 | -- | -- | 2.6E+04 | 3.0E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.6E+04** | **3.0E+05** |
| Total dissolved solids | 0 | -- | -- | 5.0E+05 | -- | -- | -- | 2.5E+07 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.5E+07** | **--** |
| Toxaphene [C] | 0 | 7.3E-01 | 2.0E-04 | 2.8E-03 | 2.8E-03 | 1.5E+00 | 1.0E-02 | 1.4E-01 | 1.4E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **1.5E+00** | **1.0E-02** | **1.4E-01** | **1.4E-01** |
| Tributyltin | 0 | 4.6E-01 | 7.2E-02 | -- | -- | 9.2E-01 | 3.6E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **9.2E-01** | **3.6E+00** | **--** | **--** |
| 1,2,4-Trichlorobenzene | 0 | -- | -- | 3.5E+01 | 7.0E+01 | -- | -- | 1.8E+03 | 3.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.8E+03** | **3.5E+03** |
| 1,1,2-Trichloroethane[C] | 0 | -- | -- | 5.9E+00 | 1.6E+02 | -- | -- | 3.0E+02 | 8.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.0E+02** | **8.0E+03** |
| Trichloroethylene [C] | 0 | -- | -- | 2.5E+01 | 3.0E+02 | -- | -- | 1.3E+03 | 1.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+03** | **1.5E+04** |
| 2,4,6-Trichlorophenol [C] | 0 | -- | -- | 1.4E+01 | 2.4E+01 | -- | -- | 7.0E+02 | 1.2E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.0E+02** | **1.2E+03** |
| 2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex) | 0 | -- | -- | 5.0E+01 | -- | -- | -- | 2.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.5E+03** | **--** |
| Vinyl Chloride[C] | 0 | -- | -- | 2.5E-01 | 2.4E+01 | -- | -- | 1.3E+01 | 1.2E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+01** | **1.2E+03** |
| Zinc | 0 | 9.4E+01 | 8.4E+01 | 7.4E+03 | 2.6E+04 | 1.9E+02 | 4.2E+03 | 3.7E+05 | 1.3E+06 | -- | -- | -- | -- | -- | -- | -- | -- | **1.9E+02** | **4.2E+03** | **3.7E+05** | **1.3E+06** |

Notes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise
2. Discharge flow is highest monthly average or Form 2C maximum for Industries and design flow for Municipals
3. Metals measured as Dissolved, unless specified otherwise
4. "C" indicates a carcinogenic parameter
5. Regular WLAs are mass balances (minus background concentration) using the % of stream flow entered above under Mixing Information.
   Antidegradation WLAs are based upon a complete mix.
6. Antideg. Baseline = (0.25(WQC - background conc.) + background conc.) for acute and chronic
   = (0.1(WQC - background conc.) + background conc.) for human health
7. WLAs established at the following stream flows: 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens and
   Harmonic Mean for Carcinogens. To apply mixing ratios from a model set the stream flow equal to (mixing ratio - 1), effluent flow equal to 1 and 100% mix.

| Metal | Target Value (SSTV) |
|---|---|
| Antimony | 2.8E+02 |
| Arsenic | 2.7E+02 |
| Barium | 1.0E+05 |
| Cadmium | 2.3E+00 |
| Chromium III | 3.7E+02 |
| Chromium VI | 1.3E+01 |
| Copper | 8.4E+00 |
| Iron | 1.5E+04 |
| Lead | 6.8E+01 |
| Manganese | 2.5E+03 |
| Mercury | 1.1E+00 |
| Nickel | 1.2E+02 |
| Selenium | 1.6E+01 |
| Silver | 1.8E+00 |
| Zinc | 7.5E+01 |

Note: do not use QL's lower than the minimum QL's provided in agency guidance

10/26/2011 5:38:54 PM

Facility = Chesterfield Power Station- Outfall 001
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 20.3
WLAc = 52.5
Q.L. = 0.1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = .100
Variance = .0036
C.V. = 0.6
97th percentile daily values = .243341
97th percentile 4 day average = .166379
97th percentile 30 day average= .120605
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.100

The evaluation above is expressed in mg/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

11/20/2011 10:10:29 AM

Facility = Chesterfield Power Station- Outfall 001
Chemical = TRC
Chronic averaging period = 4
WLAa = 38
WLAc = 550
Q.L. = 100
# samples/mo. = 4
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 20000
Variance = 1440000
C.V. = 0.6
97th percentile daily values = 48668.3
97th percentile 4 day average = 33275.8
97th percentile 30 day average= 24121.0
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Acute Toxicity
Maximum Daily Limit = 38
Average Weekly limit = 38
Average Monthly LImit = 25.9815774306533

The data are:

20000

The evaluation above is expressed in ug/L. According to GM00-2011, because chlorine is a known toxicant purposefully introduced to the effluent., a reasonable potential analysis is not needed to establish the potential to violate WQS. Instead, a limitation is forced by entering a datum of 20,000 ug/L. As shown above, a limitation is needed based on acute toxicity.

10/26/2011 4:57:25 PM

Facility = Chesterfield Power Station- Outfall 001
Chemical = Dissolved Copper
Chronic averaging period = 4
WLAa = 21
WLAc = 320
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 2
Expected Value = 1.16619
Variance = .4896
C.V. = 0.6
97th percentile daily values = 2.83782
97th percentile 4 day average = 1.94029
97th percentile 30 day average= 1.40648
# < Q.L. = 1
Model used = BPJ Assumptions, Type 1 data

No Limit is required for this material

The data are:

6
0

The limitation above is expressed in ug/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

10/26/2011 5:09:00 PM

Facility = Chesterfield Power Station- Outfall 001
Chemical = Dissolved Zinc
Chronic averaging period = 4
WLAa = 190
WLAc = 4200
Q.L. = 10
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 13
Variance = 60.84
C.V. = 0.6
97th percentile daily values = 31.6344
97th percentile 4 day average = 21.6292
97th percentile 30 day average= 15.6786
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

13

The limitation above is expressed in ug/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

10/26/2011 5:48:35 PM

Facility = Chesterfield Power Station- Outfall 001
Chemical = Chlorides
Chronic averaging period = 4
WLAa = 1700000
WLAc = 12000000
Q.L. = 100
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 30440
Variance = 3335736
C.V. = 0.6
97th percentile daily values = 74073.2
97th percentile 4 day average = 50645.7
97th percentile 30 day average= 36712.2
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

30440

The limitation above is expressed in ug/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

10/26/2011 5:04:37 PM

Facility = Chesterfield Power Station- Outfall 001
Chemical = Dissolved Mercury
Chronic averaging period = 4
WLAa = 2.8
WLAc = 39
Q.L. = 0.0006
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = .00064
Variance = .000000
C.V. = 0.6
97th percentile daily values = .001557
97th percentile 4 day average = .001064
97th percentile 30 day average= .000771
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.00064

The limitation above is expressed in ug/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

10/26/2011 5:43:33 PM

Facility = Chesterfield Power Station-Outfall 002
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 20.3
WLAc = 52.5
Q.L. = .05
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = .07
Variance = .001764
C.V. = 0.6
97th percentile daily values = .170339
97th percentile 4 day average = .116465
97th percentile 30 day average= .084423
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.070

The evaluation above is expressed in mg/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

11/20/2011 10:10:29 AM

Facility = Chesterfield Power Station- Outfall 002
Chemical = TRC
Chronic averaging period = 4
WLAa = 38
WLAc = 550
Q.L. = 100
# samples/mo. = 4
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 20000
Variance = 1440000
C.V. = 0.6
97th percentile daily values = 48668.3
97th percentile 4 day average = 33275.8
97th percentile 30 day average= 24121.0
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Acute Toxicity
Maximum Daily Limit = 38
Average Weekly limit = 38
Average Monthly LImit = 25.9815774306533

The data are:

20000

The evaluation above is expressed in ug/L. According to GM00-2011, because chlorine is a known toxicant purposefully introduced to the effluent., a reasonable potential analysis is not needed to establish the potential to violate WQS. Instead, a limitation is forced by entering a datum of 20,000 ug/L. As shown above, a limitation is needed based on acute toxicity.

10/26/2011 5:52:08 PM

Facility = Chesterfield Power Station- Outfall 002
Chemical = Dissolved Copper
Chronic averaging period = 4
WLAa = 21
WLAc = 320
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 2
Expected Value = 8.5
Variance = 26.01
C.V. = 0.6
97th percentile daily values = 20.6840
97th percentile 4 day average = 14.1422
97th percentile 30 day average= 10.2514
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

13
4

The evaluation above is expressed in mg/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

10/26/2011 5:55:53 PM

Facility = Chesterfield Power Station- Outfall 002
Chemical = Dissolved Zinc
Chronic averaging period = 4
WLAa = 190
WLAc = 4200
Q.L. = 10
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 26
Variance = 243.36
C.V. = 0.6
97th percentile daily values = 63.2688
97th percentile 4 day average = 43.2585
97th percentile 30 day average= 31.3573
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

26

The evaluation above is expressed in mg/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

10/26/2011 5:54:01 PM

Facility = Chesterfield Power Station- Outfall 002
Chemical = Dissolved Mercury
Chronic averaging period = 4
WLAa = 2.8
WLAc = 39
Q.L. = 0.0001
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = .00094
Variance = .000000
C.V. = 0.6
97th percentile daily values = .002287
97th percentile 4 day average = .001563
97th percentile 30 day average= .001133
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.00094

The evaluation above is expressed in mg/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

10/26/2011 5:50:00 PM

Facility = Chesterfield Power Station- Outfall 002
Chemical = Chlorides
Chronic averaging period = 4
WLAa = 1700000
WLAc = 12000000
Q.L. = 100
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 32010
Variance = 3688704
C.V. = 0.6
97th percentile daily values = 77893.6
97th percentile 4 day average = 53257.9
97th percentile 30 day average= 38605.7
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

32010

The evaluation above is expressed in mg/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

b. Reasonable Potential Analysis for Outfall 003

Effluent limitations for parameters submitted with the application were evaluated in accordance with DEQ Guidance Memo 00-2011. All observed pollutants and pollutants reported less than QLs that exceeded the agency accepted values were evaluated for reasonable potential to violate in stream water quality standards. Pollutants that were reported less than a DEQ accepted QL were considered absent for the purposes of this evaluation.

MSTRANTI (version 2b), a DEQ developed spreadsheet was used to calculate Waste Load Allocations (WLAs) based on mixed conditions. Stream data, effluent data and mixing ratios were entered into MSTRANTI to determine the WLAs.

Like Outfalls 001 and 002, Outfall 003 discharges to the tidal James River. However, because Outfall 003 discharges a large volume of water at the head of Farrar Gut, it creates free flowing stream characteristics in a tidal water body. Historically, discharges to Farrar Gut have been evaluated as if to a free-flowing stream because of this discharge. This approach remains appropriate and will be carried forward in the permit reissuance. Because the Outfall 003 discharge creates the free flowing stream condition, it is evaluated as if discharging to a dry ditch with zero flow. This represents a more conservative analysis than assuming tidal defaults.

STATS.EXE (version 2.0.4) is then used to evaluate reasonable potential and calculate a limitation if needed. WLAs, monitoring frequencies and reported effluent pollutant concentrations are input in STATS.EXE to evaluate each pollutant individually. Because chlorine is purposefully introduced in to the effluent, TRC limitations were forced using an assumed datum. As shown in the STATS outputs included in this section, no other limitations are needed to protect ambient aquatic Water Quality Standards at Outfall 003.

For parameters with standards based on Human Health (HH), the maximum observed values were compared to the HH WLAs calculated in MSTRANTI. The receiving stream is not designated as a PWS, so the HH PWS standards do not apply to this discharge. However, the PWS WLAs were calculated for illustrative purposes. Observed concentrations of iron and manganese exceed the Human Health PWS WLAs, but iron and manganese are aesthetic parameters and apply only at the PWS intake. Consequently, limitations for iron and manganese are not required at this time. As shown in the table below, all of the other observed values are less than the WLAs; therefore, no limitations are needed for these parameters to protect human health.

In the application, the values reported for Beta Particle and Photon Activity are in units of activity (i.e. pCi/L) whereas the applicable water quality standard is an exposure in terms of mrem/yr. The EPA has established this same standard for community potable water systems. EPA guidance states that compliance with the potable water standard may be assumed if the average annual concentration of Beta Particle and Photon Activity is less than 50 pCi/L (**Radionuclides in Drinking Water: A Small Entity Compliance Guide.** EPA 815-R-02-001, February 2002.; http://www.epa.gov/safewater/radionuclides/compliancehelp.html). Consequently, the reported concentration of Beta Particle and Photon Activity is considered to meet the applicable water quality standards. Pollutants without an applicable standard cannot be evaluated at this time.

| Pollutant | Observed Values | Human Health WLA | | Reasonable Potential (Y/N) |
|---|---|---|---|---|
| | | PWS | All Other Waters | |
| Dissolved Copper (µg/L) | 2.00 | 1300 | | N |
| Chloroform (µg/L) | 1.60 | 340 | 11000 | N |

| Pollutant | Observed Values | Human Health WLA | | Reasonable Potential (Y/N) |
|---|---|---|---|---|
| | | PWS | All Other Waters | |
| Beta Particle & Photon Activity (pCi/L) | 3.23 | 4.0 mrem/year | | N |
| Chlorides (µg/L) | 32060 | 250000 | | N |
| E. coli (N/100mL) | 30 | 126 | 126 | N |
| Dissolved Barium (µg/L) | 121* | 2000 | | N |
| Dissolved Iron (µg/L) | 560* | 300 | | Y |
| Dissolved Manganese (µg/L) | 60* | 50 | | Y |
| Sulfate (mg/L) | 57.2 | 250 | | N |

* Observed values are expressed in terms of total rather than dissolved.

# MSTRANTI DATA SOURCE REPORT

(Chesterfield Power Station: Outfall 003)

| | |
|---|---|
| **Stream Information** | |
| Mean Hardness | Refer to Outfall 003 Effluent Information |
| 90% Temperature (annual) | |
| 90% Temperature (wet season) | |
| 90% Maximum pH | |
| 10% Maximum pH | |
| Tier Designation | Flow Frequency Memo (9/16/09) |
| **Stream Flows** | |
| All Data | Per the Flow Frequency Memo (9/16/09), effluent flow from outfall 003 dominates the tidal receiving stream, Farrar Gut. Consequently, Farrar Gut is treated as a free flowing stream with Outfall 003 being the head of the stream. Ambient flows of zero are used as a conservative assumption. |
| **Mixing Information** | |
| All percentages | 100% mix assumed because effluent flow from Outfall 003 dominates the tidal flow within Farrar Gut. |
| **Effluent Information** | |
| Mean Hardness | App Data |
| 90% Temperature (annual) | 90th percentile of the max temperature reported on the monthly DMRs over the last three years. |
| 90% Temperature (wet season) | NA |
| 90% Maximum pH | The ambient stream pH based on 40 years of sampling (2-JMS099.30) was used in lieu of the single effluent sample provided in the application. Because the effluent is non-contact cooling water |

| | |
|---|---|
| 10% Maximum pH | withdrawn from the river and there is no chemical adjustment of pH, the stream values are considered a more conservative input. In addition, the single sample effluent value is within the ambient range. |
| Discharge Flow | Max Daily Flow reported in the application. |

Data Location:

Flow Frequency Analysis – Attachment 3
DMR Data – Attachment 4
App Data – Attachment 4

# FRESHWATER
# WATER QUALITY CRITERIA / WASTELOAD ALLOCATION ANALYSIS

Facility Name: Dominion Chesterfield Power Station (003) Permit No.: VA0004146

Receiving Stream: James River Version: OWP Guidance Memo 00-2011 (8/24/00)

| Stream Information | | |
|---|---|---|
| Mean Hardness (as CaCO3) = | 105 | mg/L |
| 90% Temperature (Annual) = | 53.3 | deg C |
| 90% Temperature (Wet season) = | NA | deg C |
| 90% Maximum pH = | 7.9 | SU |
| 10% Maximum pH = | 7.1 | SU |
| Tier Designation (1 or 2) = | 1 | |
| Public Water Supply (PWS) Y/N? = | y | |
| Trout Present Y/N? = | n | |
| Early Life Stages Present Y/N? = | y | |

| Stream Flows | | |
|---|---|---|
| 1Q10 (Annual) = | 0 | MGD |
| 7Q10 (Annual) = | 0 | MGD |
| 30Q10 (Annual) = | 0 | MGD |
| 1Q10 (Wet season) = | na | MGD |
| 30Q10 (Wet season) | na | MGD |
| 30Q5 = | 0 | MGD |
| Harmonic Mean = | 0 | MGD |

| Mixing Information | | |
|---|---|---|
| Annual - 1Q10 Mix = | 100 | % |
| - 7Q10 Mix = | 100 | % |
| - 30Q10 Mix = | 100 | % |
| Wet Season - 1Q10 Mix = | na | % |
| - 30Q10 Mix = | na | % |

| Effluent Information | | |
|---|---|---|
| Mean Hardness (as CaCO3) = | 105 | mg/L |
| 90% Temp (Annual) = | 53.3 | deg C |
| 90% Temp (Wet season) = | na | deg C |
| 90% Maximum pH = | 7.9 | SU |
| 10% Maximum pH = | 7.1 | SU |
| Discharge Flow = | 511 | MGD |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | **Most Limiting Allocations** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | **Acute** | **Chronic** | **HH (PWS)** | **HH** |
| Acenapthene | 5 | -- | -- | 6.7E+02 | 9.9E+02 | -- | -- | 6.7E+02 | 9.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.7E+02** | **9.9E+02** |
| Acrolein | 0 | -- | -- | 6.1E+00 | 9.3E+00 | -- | -- | 6.1E+00 | 9.3E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.1E+00** | **9.3E+00** |
| Acrylonitrile[C] | 0 | -- | -- | 5.1E-01 | 2.5E+00 | -- | -- | 5.1E-01 | 2.5E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.1E-01** | **2.5E+00** |
| Aldrin [C] | 0 | 3.0E+00 | -- | 4.9E-04 | 5.0E-04 | 3.0E+00 | -- | 4.9E-04 | 5.0E-04 | -- | -- | -- | -- | -- | -- | -- | -- | **3.0E+00** | **--** | **4.9E-04** | **5.0E-04** |
| Ammonia-N (mg/l) (Yearly) | 0 | 1.01E+01 | 2.30E-01 | -- | -- | 1.01E+01 | 2.30E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.01E+01** | **2.30E-01** | **--** | **--** |
| Ammonia-N (mg/l) (High Flow) | 0 | #VALUE! | #VALUE! | -- | -- | #VALUE! | #VALUE! | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **#VALUE!** | **#VALUE!** | **--** | **--** |
| Anthracene | 0 | -- | -- | 8.3E+03 | 4.0E+04 | -- | -- | 8.3E+03 | 4.0E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **8.3E+03** | **4.0E+04** |
| Antimony | 0 | -- | -- | 5.6E+00 | 6.4E+02 | -- | -- | 5.6E+00 | 6.4E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.6E+00** | **6.4E+02** |
| Arsenic | o | 3.4E+02 | 1.5E+02 | 1.0E+01 | -- | 3.4E+02 | 1.5E+02 | 1.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **3.4E+02** | **1.5E+02** | **1.0E+01** | **--** |
| Barium | 0 | -- | -- | 2.0E+03 | -- | -- | -- | 2.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.0E+03** | **--** |
| Benzene [C] | 0 | -- | -- | 2.2E+01 | 5.1E+02 | -- | -- | 2.2E+01 | 5.1E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.2E+01** | **5.1E+02** |
| Benzidine[C] | 0 | -- | -- | 8.6E-04 | 2.0E-03 | -- | -- | 8.6E-04 | 2.0E-03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **8.6E-04** | **2.0E-03** |
| Benzo (a) anthracene [C] | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.8E-02** | **1.8E-01** |
| Benzo (b) fluoranthene [C] | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.8E-02** | **1.8E-01** |
| Benzo (k) fluoranthene [C] | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.8E-02** | **1.8E-01** |
| Benzo (a) pyrene [C] | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.8E-02** | **1.8E-01** |
| Bis2-Chloroethyl Ether [C] | 0 | -- | -- | 3.0E-01 | 5.3E+00 | -- | -- | 3.0E-01 | 5.3E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.0E-01** | **5.3E+00** |
| Bis2-Chloroisopropyl Ether | 0 | -- | -- | 1.4E+03 | 6.5E+04 | -- | -- | 1.4E+03 | 6.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.4E+03** | **6.5E+04** |
| Bis 2-Ethylhexyl Phthalate [C] | 0 | -- | -- | 1.2E+01 | 2.2E+01 | -- | -- | 1.2E+01 | 2.2E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.2E+01** | **2.2E+01** |
| Bromoform [C] | 0 | -- | -- | 4.3E+01 | 1.4E+03 | -- | -- | 4.3E+01 | 1.4E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.3E+01** | **1.4E+03** |
| Butylbenzylphthalate | 0 | -- | -- | 1.5E+03 | 1.9E+03 | -- | -- | 1.5E+03 | 1.9E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.5E+03** | **1.9E+03** |
| Cadmium | 0 | 4.1E+00 | 1.2E+00 | 5.0E+00 | -- | 4.1E+00 | 1.2E+00 | 5.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **4.1E+00** | **1.2E+00** | **5.0E+00** | **--** |
| Carbon Tetrachloride [C] | 0 | -- | -- | 2.3E+00 | 1.6E+01 | -- | -- | 2.3E+00 | 1.6E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.3E+00** | **1.6E+01** |
| Chlordane [C] | 0 | 2.4E+00 | 4.3E-03 | 8.0E-03 | 8.1E-03 | 2.4E+00 | 4.3E-03 | 8.0E-03 | 8.1E-03 | -- | -- | -- | -- | -- | -- | -- | -- | **2.4E+00** | **4.3E-03** | **8.0E-03** | **8.1E-03** |
| Chloride | 0 | 8.6E+05 | 2.3E+05 | 2.5E+05 | -- | 8.6E+05 | 2.3E+05 | 2.5E+05 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **8.6E+05** | **2.3E+05** | **2.5E+05** | **--** |
| TRC | 0 | 1.9E+01 | 1.1E+01 | -- | -- | 1.9E+01 | 1.1E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.9E+01** | **1.1E+01** | **--** | **--** |
| Chlorobenzene | 0 | -- | -- | 1.3E+02 | 1.6E+03 | -- | -- | 1.3E+02 | 1.6E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+02** | **1.6E+03** |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | **Most Limiting Allocations** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | **Acute** | **Chronic** | **HH (PWS)** | **HH** |
| Chlorodibromomethane[C] | 0 | -- | -- | 4.0E+00 | 1.3E+02 | -- | -- | 4.0E+00 | 1.3E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.0E+00** | **1.3E+02** |
| Chloroform | 0 | -- | -- | 3.4E+02 | 1.1E+04 | -- | -- | 3.4E+02 | 1.1E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.4E+02** | **1.1E+04** |
| 2-Chloronaphthalene | 0 | -- | -- | 1.0E+03 | 1.6E+03 | -- | -- | 1.0E+03 | 1.6E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+03** | **1.6E+03** |
| 2-Chlorophenol | 0 | -- | -- | 8.1E+01 | 1.5E+02 | -- | -- | 8.1E+01 | 1.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **8.1E+01** | **1.5E+02** |
| Chlorpyrifos | 0 | 8.3E-02 | 4.1E-02 | -- | -- | 8.3E-02 | 4.1E-02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **8.3E-02** | **4.1E-02** | **--** | **--** |
| Chromium III | 0 | 5.9E+02 | 7.7E+01 | -- | -- | 5.9E+02 | 7.7E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **5.9E+02** | **7.7E+01** | **--** | **--** |
| Chromium VI | 0 | 1.6E+01 | 1.1E+01 | -- | -- | 1.6E+01 | 1.1E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.6E+01** | **1.1E+01** | **--** | **--** |
| Chromium, Total | 0 | -- | -- | 1.0E+02 | -- | -- | -- | 1.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+02** | **--** |
| Chrysene [C] | 0 | -- | -- | 3.8E-03 | 1.8E-02 | -- | -- | 3.8E-03 | 1.8E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.8E-03** | **1.8E-02** |
| Copper | 0 | 1.4E+01 | 9.3E+00 | 1.3E+03 | -- | 1.4E+01 | 9.3E+00 | 1.3E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.4E+01** | **9.3E+00** | **1.3E+03** | **--** |
| Cyanide, Free | 0 | 2.2E+01 | 5.2E+00 | 1.4E+02 | 1.6E+04 | 2.2E+01 | 5.2E+00 | 1.4E+02 | 1.6E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **2.2E+01** | **5.2E+00** | **1.4E+02** | **1.6E+04** |
| DDD [C] | 0 | -- | -- | 3.1E-03 | 3.1E-03 | -- | -- | 3.1E-03 | 3.1E-03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.1E-03** | **3.1E-03** |
| DDE [C] | 0 | -- | -- | 2.2E-03 | 2.2E-03 | -- | -- | 2.2E-03 | 2.2E-03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.2E-03** | **2.2E-03** |
| DDT [C] | 0 | 1.1E+00 | 1.0E-03 | 2.2E-03 | 2.2E-03 | 1.1E+00 | 1.0E-03 | 2.2E-03 | 2.2E-03 | -- | -- | -- | -- | -- | -- | -- | -- | **1.1E+00** | **1.0E-03** | **2.2E-03** | **2.2E-03** |
| Demeton | 0 | -- | 1.0E-01 | -- | -- | -- | 1.0E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **1.0E-01** | **--** | **--** |
| Diazinon | 0 | 1.7E-01 | 1.7E-01 | -- | -- | 1.7E-01 | 1.7E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.7E-01** | **1.7E-01** | **--** | **--** |
| Dibenz(a,h)anthracene [C] | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.8E-02** | **1.8E-01** |
| 1,2-Dichlorobenzene | 0 | -- | -- | 4.2E+02 | 1.3E+03 | -- | -- | 4.2E+02 | 1.3E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.2E+02** | **1.3E+03** |
| 1,3-Dichlorobenzene | 0 | -- | -- | 3.2E+02 | 9.6E+02 | -- | -- | 3.2E+02 | 9.6E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.2E+02** | **9.6E+02** |
| 1,4-Dichlorobenzene | 0 | -- | -- | 6.3E+01 | 1.9E+02 | -- | -- | 6.3E+01 | 1.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.3E+01** | **1.9E+02** |
| 3,3-Dichlorobenzidine[C] | 0 | -- | -- | 2.1E-01 | 2.8E-01 | -- | -- | 2.1E-01 | 2.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.1E-01** | **2.8E-01** |
| Dichlorobromomethane [C] | 0 | -- | -- | 5.5E+00 | 1.7E+02 | -- | -- | 5.5E+00 | 1.7E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.5E+00** | **1.7E+02** |
| 1,2-Dichloroethane [C] | 0 | -- | -- | 3.8E+00 | 3.7E+02 | -- | -- | 3.8E+00 | 3.7E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.8E+00** | **3.7E+02** |
| 1,1-Dichloroethylene | 0 | -- | -- | 3.3E+02 | 7.1E+03 | -- | -- | 3.3E+02 | 7.1E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.3E+02** | **7.1E+03** |
| 1,2-trans-dichloroethylene | 0 | -- | -- | 1.4E+02 | 1.0E+04 | -- | -- | 1.4E+02 | 1.0E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.4E+02** | **1.0E+04** |
| 2,4-Dichlorophenol | 0 | -- | -- | 7.7E+01 | 2.9E+02 | -- | -- | 7.7E+01 | 2.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.7E+01** | **2.9E+02** |
| 2,4-Dichlorophenoxy acetic acid (2,4-D) | 0 | -- | -- | 1.0E+02 | -- | -- | -- | 1.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+02** | **--** |
| 1,2-Dichloropropane[C] | 0 | -- | -- | 5.0E+00 | 1.5E+02 | -- | -- | 5.0E+00 | 1.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E+00** | **1.5E+02** |
| 1,3-Dichloropropene [C] | 0 | -- | -- | 3.4E+00 | 2.1E+02 | -- | -- | 3.4E+00 | 2.1E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.4E+00** | **2.1E+02** |
| Dieldrin [C] | 0 | 2.4E-01 | 5.6E-02 | 5.2E-04 | 5.4E-04 | 2.4E-01 | 5.6E-02 | 5.2E-04 | 5.4E-04 | -- | -- | -- | -- | -- | -- | -- | -- | **2.4E-01** | **5.6E-02** | **5.2E-04** | **5.4E-04** |
| Diethyl Phthalate | 0 | -- | -- | 1.7E+04 | 4.4E+04 | -- | -- | 1.7E+04 | 4.4E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.7E+04** | **4.4E+04** |
| 2,4-Dimethylphenol | 0 | -- | -- | 3.8E+02 | 8.5E+02 | -- | -- | 3.8E+02 | 8.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.8E+02** | **8.5E+02** |
| Dimethyl Phthalate | 0 | -- | -- | 2.7E+05 | 1.1E+06 | -- | -- | 2.7E+05 | 1.1E+06 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.7E+05** | **1.1E+06** |
| Di-n-Butyl Phthalate | 0 | -- | -- | 2.0E+03 | 4.5E+03 | -- | -- | 2.0E+03 | 4.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.0E+03** | **4.5E+03** |
| 2,4 Dinitrophenol | 0 | -- | -- | 6.9E+01 | 5.3E+03 | -- | -- | 6.9E+01 | 5.3E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.9E+01** | **5.3E+03** |
| 2-Methyl-4,6-Dinitrophenol | 0 | -- | -- | 1.3E+01 | 2.8E+02 | -- | -- | 1.3E+01 | 2.8E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+01** | **2.8E+02** |
| 2,4-Dinitrotoluene [C] | 0 | -- | -- | 1.1E+00 | 3.4E+01 | -- | -- | 1.1E+00 | 3.4E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.1E+00** | **3.4E+01** |
| Dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin | 0 | -- | -- | 5.0E-08 | 5.1E-08 | -- | -- | 5.0E-08 | 5.1E-08 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E-08** | **5.1E-08** |
| 1,2-Diphenylhydrazine[C] | 0 | -- | -- | 3.6E-01 | 2.0E+00 | -- | -- | 3.6E-01 | 2.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.6E-01** | **2.0E+00** |
| Alpha-Endosulfan | 0 | 2.2E-01 | 5.6E-02 | 6.2E+01 | 8.9E+01 | 2.2E-01 | 5.6E-02 | 6.2E+01 | 8.9E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **2.2E-01** | **5.6E-02** | **6.2E+01** | **8.9E+01** |
| Beta-Endosulfan | 0 | 2.2E-01 | 5.6E-02 | 6.2E+01 | 8.9E+01 | 2.2E-01 | 5.6E-02 | 6.2E+01 | 8.9E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **2.2E-01** | **5.6E-02** | **6.2E+01** | **8.9E+01** |
| Alpha + Beta Endosulfan | 0 | 2.2E-01 | 5.6E-02 | -- | -- | 2.2E-01 | 5.6E-02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **2.2E-01** | **5.6E-02** | **--** | **--** |
| Endosulfan Sulfate | 0 | -- | -- | 6.2E+01 | 8.9E+01 | -- | -- | 6.2E+01 | 8.9E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.2E+01** | **8.9E+01** |
| Endrin | 0 | 8.6E-02 | 3.6E-02 | 5.9E-02 | 6.0E-02 | 8.6E-02 | 3.6E-02 | 5.9E-02 | 6.0E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **8.6E-02** | **3.6E-02** | **5.9E-02** | **6.0E-02** |
| Endrin Aldehyde | 0 | -- | -- | 2.9E-01 | 3.0E-01 | -- | -- | 2.9E-01 | 3.0E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.9E-01** | **3.0E-01** |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | **Most Limiting Allocations** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | **Acute** | **Chronic** | **HH (PWS)** | **HH** |
| Ethylbenzene | 0 | -- | -- | 5.3E+02 | 2.1E+03 | -- | -- | 5.3E+02 | 2.1E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.3E+02** | **2.1E+03** |
| Fluoranthene | 0 | -- | -- | 1.3E+02 | 1.4E+02 | -- | -- | 1.3E+02 | 1.4E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+02** | **1.4E+02** |
| Fluorene | 0 | -- | -- | 1.1E+03 | 5.3E+03 | -- | -- | 1.1E+03 | 5.3E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.1E+03** | **5.3E+03** |
| Foaming Agents | 0 | -- | -- | 5.0E+02 | -- | -- | -- | 5.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E+02** | **--** |
| Guthion | 0 | -- | 1.0E-02 | -- | -- | -- | 1.0E-02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **1.0E-02** | **--** | **--** |
| Heptachlor [C] | 0 | 5.2E-01 | 3.8E-03 | 7.9E-04 | 7.9E-04 | 5.2E-01 | 3.8E-03 | 7.9E-04 | 7.9E-04 | -- | -- | -- | -- | -- | -- | -- | -- | **5.2E-01** | **3.8E-03** | **7.9E-04** | **7.9E-04** |
| Heptachlor Epoxide[C] | 0 | 5.2E-01 | 3.8E-03 | 3.9E-04 | 3.9E-04 | 5.2E-01 | 3.8E-03 | 3.9E-04 | 3.9E-04 | -- | -- | -- | -- | -- | -- | -- | -- | **5.2E-01** | **3.8E-03** | **3.9E-04** | **3.9E-04** |
| Hexachlorobenzene[C] | 0 | -- | -- | 2.8E-03 | 2.9E-03 | -- | -- | 2.8E-03 | 2.9E-03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.8E-03** | **2.9E-03** |
| Hexachlorobutadiene[C] | 0 | -- | -- | 4.4E+00 | 1.8E+02 | -- | -- | 4.4E+00 | 1.8E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.4E+00** | **1.8E+02** |
| Hexachlorocyclohexane Alpha-BHC[C] | 0 | -- | -- | 2.6E-02 | 4.9E-02 | -- | -- | 2.6E-02 | 4.9E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.6E-02** | **4.9E-02** |
| Hexachlorocyclohexane Beta-BHC[C] | 0 | -- | -- | 9.1E-02 | 1.7E-01 | -- | -- | 9.1E-02 | 1.7E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **9.1E-02** | **1.7E-01** |
| Hexachlorocyclohexane Gamma-BHC[C] (Lindane) | 0 | 9.5E-01 | -- | 9.8E-01 | 1.8E+00 | 9.5E-01 | -- | 9.8E-01 | 1.8E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **9.5E-01** | **--** | **9.8E-01** | **1.8E+00** |
| Hexachlorocyclopentadiene | 0 | -- | -- | 4.0E+01 | 1.1E+03 | -- | -- | 4.0E+01 | 1.1E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.0E+01** | **1.1E+03** |
| Hexachloroethane[C] | 0 | -- | -- | 1.4E+01 | 3.3E+01 | -- | -- | 1.4E+01 | 3.3E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.4E+01** | **3.3E+01** |
| Hydrogen Sulfide | 0 | -- | 2.0E+00 | -- | -- | -- | 2.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **2.0E+00** | **--** | **--** |
| Indeno (1,2,3-cd) pyrene [C] | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.8E-02** | **1.8E-01** |
| Iron | 0 | -- | -- | 3.0E+02 | -- | -- | -- | 3.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.0E+02** | **--** |
| Isophorone[C] | 0 | -- | -- | 3.5E+02 | 9.6E+03 | -- | -- | 3.5E+02 | 9.6E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.5E+02** | **9.6E+03** |
| Kepone | 0 | -- | 0.0E+00 | -- | -- | -- | 0.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **0.0E+00** | **--** | **--** |
| Lead | 0 | 1.3E+02 | 1.4E+01 | 1.5E+01 | -- | 1.3E+02 | 1.4E+01 | 1.5E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.3E+02** | **1.4E+01** | **1.5E+01** | **--** |
| Malathion | 0 | -- | 1.0E-01 | -- | -- | -- | 1.0E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **1.0E-01** | **--** | **--** |
| Manganese | 0 | -- | -- | 5.0E+01 | -- | -- | -- | 5.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E+01** | **--** |
| Mercury | 0 | 1.4E+00 | 7.7E-01 | - - | - - | 1.4E+00 | 7.7E-01 | - - | - - | -- | -- | -- | -- | -- | -- | -- | -- | **1.4E+00** | **7.7E-01** | **- -** | **- -** |
| Methyl Bromide | 0 | -- | -- | 4.7E+01 | 1.5E+03 | -- | -- | 4.7E+01 | 1.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.7E+01** | **1.5E+03** |
| Methylene Chloride [C] | 0 | -- | -- | 4.6E+01 | 5.9E+03 | -- | -- | 4.6E+01 | 5.9E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.6E+01** | **5.9E+03** |
| Methoxychlor | 0 | -- | 3.0E-02 | 1.0E+02 | -- | -- | 3.0E-02 | 1.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **3.0E-02** | **1.0E+02** | **--** |
| Mirex | 0 | -- | 0.0E+00 | -- | -- | -- | 0.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **0.0E+00** | **--** | **--** |
| Nickel | 0 | 1.9E+02 | 2.1E+01 | 6.1E+02 | 4.6E+03 | 1.9E+02 | 2.1E+01 | 6.1E+02 | 4.6E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **1.9E+02** | **2.1E+01** | **6.1E+02** | **4.6E+03** |
| Nitrate (as N) | 0 | -- | -- | 1.0E+04 | -- | -- | -- | 1.0E+04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+04** | **--** |
| Nitrobenzene | 0 | -- | -- | 1.7E+01 | 6.9E+02 | -- | -- | 1.7E+01 | 6.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.7E+01** | **6.9E+02** |
| N-Nitrosodimethylamine[C] | 0 | -- | -- | 6.9E-03 | 3.0E+01 | -- | -- | 6.9E-03 | 3.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.9E-03** | **3.0E+01** |
| N-Nitrosodiphenylamine[C] | 0 | -- | -- | 3.3E+01 | 6.0E+01 | -- | -- | 3.3E+01 | 6.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.3E+01** | **6.0E+01** |
| N-Nitrosodi-n-propylamine[C] | 0 | -- | -- | 5.0E-02 | 5.1E+00 | -- | -- | 5.0E-02 | 5.1E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E-02** | **5.1E+00** |
| Nonylphenol | 0 | 2.8E+01 | 6.6E+00 | -- | -- | 2.8E+01 | 6.6E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **2.8E+01** | **6.6E+00** | **--** | **--** |
| Parathion | 0 | 6.5E-02 | 1.3E-02 | -- | -- | 6.5E-02 | 1.3E-02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **6.5E-02** | **1.3E-02** | **--** | **--** |
| PCB Total[C] | 0 | -- | 1.4E-02 | 6.4E-04 | 6.4E-04 | -- | 1.4E-02 | 6.4E-04 | 6.4E-04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **1.4E-02** | **6.4E-04** | **6.4E-04** |
| Pentachlorophenol [C] | 0 | 9.6E+00 | 7.4E+00 | 2.7E+00 | 3.0E+01 | 9.6E+00 | 7.4E+00 | 2.7E+00 | 3.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **9.6E+00** | **7.4E+00** | **2.7E+00** | **3.0E+01** |
| Phenol | 0 | -- | -- | 1.0E+04 | 8.6E+05 | -- | -- | 1.0E+04 | 8.6E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+04** | **8.6E+05** |
| Pyrene | 0 | -- | -- | 8.3E+02 | 4.0E+03 | -- | -- | 8.3E+02 | 4.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **8.3E+02** | **4.0E+03** |
| Radionuclides | 0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **--** | **--** |
| Gross Alpha Activity (pCi/L) | 0 | -- | -- | 1.5E+01 | -- | -- | -- | 1.5E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.5E+01** | **--** |
| Beta and Photon Activity (mrem/yr) | 0 | -- | -- | 4.0E+00 | -- | -- | -- | 4.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.0E+00** | **--** |
| Radium 226 + 228 (pCi/L) | 0 | -- | -- | 5.0E+00 | -- | -- | -- | 5.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E+00** | **--** |
| Uranium (ug/l) | 0 | -- | -- | 3.0E+01 | -- | -- | -- | 3.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.0E+01** | **--** |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | **Most Limiting Allocations** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | **Acute** | **Chronic** | **HH (PWS)** | **HH** |
| Selenium, Total Recoverable | 0 | 2.0E+01 | 5.0E+00 | 1.7E+02 | 4.2E+03 | 2.0E+01 | 5.0E+00 | 1.7E+02 | 4.2E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **2.0E+01** | **5.0E+00** | **1.7E+02** | **4.2E+03** |
| Silver | 0 | 3.8E+00 | -- | -- | -- | 3.8E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **3.8E+00** | **--** | **--** | **--** |
| Sulfate | 0 | -- | -- | 2.5E+05 | -- | -- | -- | 2.5E+05 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.5E+05** | **--** |
| 1,1,2,2-Tetrachloroethane$^C$ | 0 | -- | -- | 1.7E+00 | 4.0E+01 | -- | -- | 1.7E+00 | 4.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.7E+00** | **4.0E+01** |
| Tetrachloroethylene$^C$ | 0 | -- | -- | 6.9E+00 | 3.3E+01 | -- | -- | 6.9E+00 | 3.3E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.9E+00** | **3.3E+01** |
| Thallium | 0 | -- | -- | 2.4E-01 | 4.7E-01 | -- | -- | 2.4E-01 | 4.7E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.4E-01** | **4.7E-01** |
| Toluene | 0 | -- | -- | 5.1E+02 | 6.0E+03 | -- | -- | 5.1E+02 | 6.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.1E+02** | **6.0E+03** |
| Total dissolved solids | 0 | -- | -- | 5.0E+05 | -- | -- | -- | 5.0E+05 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E+05** | **--** |
| Toxaphene $^C$ | 0 | 7.3E-01 | 2.0E-04 | 2.8E-03 | 2.8E-03 | 7.3E-01 | 2.0E-04 | 2.8E-03 | 2.8E-03 | -- | -- | -- | -- | -- | -- | -- | -- | **7.3E-01** | **2.0E-04** | **2.8E-03** | **2.8E-03** |
| Tributyltin | 0 | 4.6E-01 | 7.2E-02 | -- | -- | 4.6E-01 | 7.2E-02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **4.6E-01** | **7.2E-02** | **--** | **--** |
| 1,2,4-Trichlorobenzene | 0 | -- | -- | 3.5E+01 | 7.0E+01 | -- | -- | 3.5E+01 | 7.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.5E+01** | **7.0E+01** |
| 1,1,2-Trichloroethane$^C$ | 0 | -- | -- | 5.9E+00 | 1.6E+02 | -- | -- | 5.9E+00 | 1.6E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.9E+00** | **1.6E+02** |
| Trichloroethylene $^C$ | 0 | -- | -- | 2.5E+01 | 3.0E+02 | -- | -- | 2.5E+01 | 3.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.5E+01** | **3.0E+02** |
| 2,4,6-Trichlorophenol $^C$ | 0 | -- | -- | 1.4E+01 | 2.4E+01 | -- | -- | 1.4E+01 | 2.4E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.4E+01** | **2.4E+01** |
| 2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex) | 0 | -- | -- | 5.0E+01 | -- | -- | -- | 5.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.0E+01** | **--** |
| Vinyl Chloride$^C$ | 0 | -- | -- | 2.5E-01 | 2.4E+01 | -- | -- | 2.5E-01 | 2.4E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.5E-01** | **2.4E+01** |
| Zinc | 0 | 1.2E+02 | 1.2E+02 | 7.4E+03 | 2.6E+04 | 1.2E+02 | 1.2E+02 | 7.4E+03 | 2.6E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **1.2E+02** | **1.2E+02** | **7.4E+03** | **2.6E+04** |

Notes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise
2. Discharge flow is highest monthly average or Form 2C maximum for Industries and design flow for Municipals
3. Metals measured as Dissolved, unless specified otherwise
4. "C" indicates a carcinogenic parameter
5. Regular WLAs are mass balances (minus background concentration) using the % of stream flow entered above under Mixing Information. Antidegradation WLAs are based upon a complete mix.
6. Antideg. Baseline = (0.25(WQC - background conc.) + background conc.) for acute and chronic
   = (0.1(WQC - background conc.) + background conc.) for human health
7. WLAs established at the following stream flows: 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens and Harmonic Mean for Carcinogens. To apply mixing ratios from a model set the stream flow equal to (mixing ratio - 1), effluent flow equal to 1 and 100% mix.

| Metal | Target Value (SSTV) |
|---|---|
| Antimony | 5.6E+00 |
| Arsenic | 1.0E+01 |
| Barium | 2.0E+03 |
| Cadmium | 7.1E-01 |
| Chromium III | 4.6E+01 |
| Chromium VI | 6.4E+00 |
| Copper | 5.6E+00 |
| Iron | 3.0E+02 |
| Lead | 8.6E+00 |
| Manganese | 5.0E+01 |
| Mercury | 4.6E-01 |
| Nickel | 1.3E+01 |
| Selenium | 3.0E+00 |
| Silver | 1.5E+00 |
| Zinc | 4.9E+01 |

Note: do not use QL's lower than the minimum QL's provided in agency guidance

10/29/2011 1:21:59 PM

Facility = Chesterfield Power Station- Outfall 003
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 10.1
WLAc = 0.230
Q.L. = 0.08
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = .08
Variance = .002304
C.V. = 0.6
97th percentile daily values = .194673
97th percentile 4 day average = .133103
97th percentile 30 day average= .096484
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.080

The evaluation above is expressed in mg/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

12/7/2011 1:39:23 PM

Facility = Chesterfield Power Station- Outfall 003
Chemical = TRC
Chronic averaging period = 4
WLAa = 19
WLAc = 11
Q.L. = 0.1
# samples/mo. = 4
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 20000
Variance = 1440000
C.V. = 0.6
97th percentile daily values = 48668.3
97th percentile 4 day average = 33275.8
97th percentile 30 day average= 24121.0
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 16.0883226245855
Average Weekly Limit = 16.0883226245856
Average Monthly Limit = 11

The data are:

20000

The evaluation above is expressed in ug/L. According to GM00-2011, because chlorine is a known toxicant purposefully introduced to the effluent., a reasonable potential analysis is not needed to establish the potential to violate WQS. Instead, a limitation is forced by entering a datum of 20,000 ug/L. As shown above, a limitation is needed based on chronic toxicity.

10/29/2011 1:26:05 PM

Facility = Chesterfield Power Station- Outfall 003
Chemical = Dissolved copper
Chronic averaging period = 30
WLAa = 14
WLAc = 9.3
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 2
Variance = 1.44
C.V. = 0.6
97th percentile daily values = 4.86683
97th percentile 4 day average = 3.32758
97th percentile 30 day average= 2.41210
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

2

The evaluation above is expressed in ug/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

10/29/2011 1:28:25 PM

Facility = Chesterfield Power Station- Outfall 003
Chemical = Dissolved mercury
Chronic averaging period = 4
WLAa = 1.4
WLAc = 0.77
Q.L. = 0.0001
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = .00116
Variance = .000000
C.V. = 0.6
97th percentile daily values = .002822
97th percentile 4 day average = .001929
97th percentile 30 day average= .001399
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.00116

The evaluation above is expressed in ug/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

10/29/2011 1:40:40 PM

Facility = Chesterfield Power Station- Outfall 003
Chemical = chlorides
Chronic averaging period = 4
WLAa = 860000
WLAc = 230000
Q.L. = 100
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 32060
Variance = 3700236
C.V. = 0.6
97th percentile daily values = 78015.3
97th percentile 4 day average = 53341.1
97th percentile 30 day average= 38666.0
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

32060

The evaluation above is expressed in ug/L. As shown, reasonable potential to violate in stream WQS does not exist. Consequently, a limitation is not required at this time.

c. Reasonable Potential Analysis for Outfalls 004 and 005

Effluent limitations for parameters submitted with the application were evaluated in accordance with DEQ Guidance Memo 00-2011. All observed pollutants and pollutants reported less than QLs that exceeded the agency accepted values were evaluated for reasonable potential to violate in stream water quality standards. Pollutants that were reported less than a DEQ accepted QL were considered absent for the purposes of this evaluation.

MSTRANTI (version 2b), a DEQ developed spreadsheet was used to calculate Waste Load Allocations (WLAs) based on mixed conditions. Stream data, effluent data and mixing ratios were entered into MSTRANTI to determine the WLAs.

Outfall 004 discharges to the upper end of Farrar Gut (river mile 3.75). Outfall 005 discharges to Farrar Gut near its confluence with the James River (river mile 0.37). As explained in Part b. of this Attachment, discharges to Farrar Gut are evaluated as if discharging to a free flowing stream consisting of the Outfall 003 discharge. Permit limitations are based on conservative low flow conditions, in which the effluent has the greatest potential to impact the receiving stream. Consequently, the $10^{th}$ percentile of the 30 day average flows reported on the DMRs was used as the ambient flow. This analysis treats Outfalls 004 and 005 as a single discharge to the upper end of Farrar Gut. The highest of the maximum of the 30 day average values from the DMR, average of the 30 day max values from the DMR, or the 30 day max average values reported on Form 2C was selected for each outfall and then summed to establish the effluent flow. Based on the hydraulic dynamics and turbulence at the head of the Gut, 100% mix is assumed. This approach of evaluating the discharges together and choosing the most conservative inputs to MSTRANTI generates conservative WLAs for the subsequent reasonable potential analysis and is consistent with the 2004 permitting approach.

STATS.EXE (version 2.0.4) was then used to evaluate reasonable potential and calculate a limitation if needed. WLAs, monitoring frequencies and reported effluent pollutant concentrations were input in STATS.EXE to evaluate each pollutant individually. As shown in the STATS outputs included in this section, no limitations other than ammonia are needed to protect ambient aquatic Water Quality Standards at Outfalls 004 and 005.

In the 2004 permit ammonia concentration limitations were established because ammonia was a toxic pollutant purposefully introduced in the effluent. A limitation was forced in STATS.exe and assigned in the 2004 permit. Due to changes in the ambient and effluent flows since 2004, the ammonia WLAs for this reissuance are lower than the 2004 WLAs. An ammonia limitation was once again forced using the new WLAs, and the resultant limitations are more stringent than the 2004 limitations. Effluent data reported since 2005 indicate compliance with the proposed more stringent effluent limitations. Consequently, a compliance schedule is not appropriate. The new limitations will become effective upon permit reissuance. An ammonia limitation was not assigned for Outfall 005 in 2004 because it was not anticipated that a significant amount of ammonia would transfer to the New Ash Pond with dredging activity. Monitoring required during the 2004 permit term has confirmed this assumption and no further monitoring is warranted for Outfall 005 in the permit reissuance.

For parameters with standards based on Human Health (HH), the maximum observed values were compared to the HH WLAs calculated in MSTRANTI. The receiving stream is not designated as a PWS, so the HH PWS standards do not apply to this discharge. However, the PWS WLAs were calculated for illustrative purposes. As shown in the table below, all of the observed values were several orders of magnitude less than the WLAs; therefore, no limitations are needed for these parameters to protect human health. Pollutants without an applicable standard cannot be evaluated at this time.

| Pollutant | Observed Value | | Human Health WLA | | Reasonable Potential (Y/N) |
|---|---|---|---|---|---|
| | Outfall 004 | Outfall 005 | PWS | All Other Waters | |
| Dissolved Antimony (µg/L) | 8.00 | | 150 | 17000 | N |
| Dissolved Arsenic (µg/L) | 41.00 | 5.00 | 260 | | N |
| Dissolved Cadmium (µg/L) | 1.10 | | 130 | | N |
| Total Chromium (µg/L) | 2.00 | | 2600 | | N |
| Dissolved Copper (µg/L) | 8.00 | | 34000 | | N |
| Dissolved Nickel (µg/L) | 25.00 | | 16000 | 120000 | N |
| Total Selenium (µg/L) | 19 | 6 | 4500 | 110000 | N |
| Dissolved Thallium (µg/L) | 0.50 | 0.50 | 6.3 | 12 | N |
| Dissolved Zinc (µg/L) | 26.00 | | 200000 | 690000 | N |
| Dissolved Barium (µg/L) | 343* | 177* | 53000 | | N |
| Dissolved Iron (µg/L) | 70* | 390* | 7900 | | N |
| Dissolved Manganese (µg/L) | 80* | 80* | 1300 | | N |
| Sulfate (mg/L) | 150.31 | 76.58 | 6600 | | N |
| Beta Particle & Photon Activity (pCi/L) | | 2.88 | 110 mrem/year | | N |
| Gross Alpha Particle Activity (pCi/L) | 4.44 | | 400 | | N |
| Chlorides (µg/L) | 118320 | 4840 | 6600000 | | N |

* Observed values are expressed in terms of total rather than dissolved.

# MSTRANTI DATA SOURCE REPORT

(Chesterfield Power Station: Outfall 004 & 005)

| Stream Information | |
|---|---|
| Mean Hardness | Refer to Outfall 003 Effluent Information |
| 90% Temperature (annual) | |
| 90% Temperature (wet season) | |
| 90% Maximum pH | |
| 10% Maximum pH | |
| Tier Designation | Flow Frequency Memo (9/16/09) |
| **Stream Flows** | |
| All Data | Per the Flow Frequency Memo (9/16/09), effluent flow from outfall 003 dominates the tidal receiving stream, Farrar Gut. Consequently, the 10$^{th}$ percentile of the reported discharge flows from outfall 003 is used for a conservative analysis of outfalls 004 & 005. |
| **Mixing Information** | |
| All percentages | Assume complete mix. |
| **Effluent Information** | |
| Mean Hardness | The lesser of the two values provided in the application for Outfalls 004 and 005. |
| 90% Temperature (annual) | Max temperature reported on the Application serves as a surrogate for P90. Given the limited data set, the max value is the best estimate available. The max value reported for Outfall 004 is used in this analysis because it is the higher value and the more conservative input. |
| 90% Temperature (wet season) | NA |

| | |
|---|---|
| 90% Maximum pH | 90th percentile of the max pH from Outfall 004(higher of the two) and 10th percentile of the max pH from Outfall 004 (lower of the two). This approach is considered most conservative because it provides for the full range of pH values from the two outfalls. |
| 10% Maximum pH | |
| Discharge Flow | Sum of the flows from 004 and 005 (greater of the max monthly average flow and average daily max flow) reported on the DMRs. This sum is greater than the sum of the max 30 day values reported in the application for outfalls 004 and 005; consequently DMR data is used to be conservative. 15.3 MGD (004) + 4.83 MGD (005) = 20.13 MGD |

Data Location:

Flow Frequency Analysis – Attachment 3
DMR Data – Attachment 4
App Data – Attachment 4

# FRESHWATER
# WATER QUALITY CRITERIA / WASTELOAD ALLOCATION ANALYSIS

Facility Name: Dominion Chesterfield Power Station (004-005) Permit No.: VA0004146

Receiving Stream: James River Version: OWP Guidance Memo 00-2011 (8/24/00)

| Stream Information | | |
|---|---|---|
| Mean Hardness (as CaCO3) = | 105 | mg/L |
| 90% Temperature (Annual) = | 53.3 | deg C |
| 90% Temperature (Wet season) = | NA | deg C |
| 90% Maximum pH = | 7.9 | SU |
| 10% Maximum pH = | 7.1 | SU |
| Tier Designation (1 or 2) = | 1 | |
| Public Water Supply (PWS) Y/N? = | y | |
| Trout Present Y/N? = | n | |
| Early Life Stages Present Y/N? = | y | |

| Stream Flows | | |
|---|---|---|
| 1Q10 (Annual) = | 511 | MGD |
| 7Q10 (Annual) = | 511 | MGD |
| 30Q10 (Annual) = | 511 | MGD |
| 1Q10 (Wet season) = | na | MGD |
| 30Q10 (Wet season) | na | MGD |
| 30Q5 = | 511 | MGD |
| Harmonic Mean = | 511 | MGD |

| Mixing Information | | |
|---|---|---|
| Annual - 1Q10 Mix = | 100 | % |
| - 7Q10 Mix = | 100 | % |
| - 30Q10 Mix = | 100 | % |
| Wet Season - 1Q10 Mix = | na | % |
| - 30Q10 Mix = | na | % |

| Effluent Information | | |
|---|---|---|
| Mean Hardness (as CaCO3) = | 109 | mg/L |
| 90% Temp (Annual) = | 32.2 | deg C |
| 90% Temp (Wet season) = | na | deg C |
| 90% Maximum pH = | 8.1 | SU |
| 10% Maximum pH = | 7.1 | SU |
| Discharge Flow = | 20.13 | MGD |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | **Most Limiting Allocations** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | **Acute** | **Chronic** | **HH (PWS)** | **HH** |
| Acenapthene | 5 | -- | -- | 6.7E+02 | 9.9E+02 | -- | -- | 1.8E+04 | 2.6E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.8E+04** | **2.6E+04** |
| Acrolein | 0 | -- | -- | 6.1E+00 | 9.3E+00 | -- | -- | 1.6E+02 | 2.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.6E+02** | **2.5E+02** |
| Acrylonitrile C | 0 | -- | -- | 5.1E-01 | 2.5E+00 | -- | -- | 1.3E+01 | 6.6E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+01** | **6.6E+01** |
| Aldrin C | 0 | 3.0E+00 | -- | 4.9E-04 | 5.0E-04 | 7.9E+01 | -- | 1.3E-02 | 1.3E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **7.9E+01** | **--** | **1.3E-02** | **1.3E-02** |
| Ammonia-N (mg/l) (Yearly) | 0 | 1.00E+01 | 2.40E-01 | -- | -- | 2.64E+02 | 6.33E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **2.64E+02** | **6.33E+00** | **--** | **--** |
| Ammonia-N (mg/l) (High Flow) | 0 | #VALUE! | #VALUE! | -- | -- | #VALUE! | #VALUE! | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **#VALUE!** | **#VALUE!** | **--** | **--** |
| Anthracene | 0 | -- | -- | 8.3E+03 | 4.0E+04 | -- | -- | 2.2E+05 | 1.1E+06 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.2E+05** | **1.1E+06** |
| Antimony | 0 | -- | -- | 5.6E+00 | 6.4E+02 | -- | -- | 1.5E+02 | 1.7E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.5E+02** | **1.7E+04** |
| Arsenic | o | 3.4E+02 | 1.5E+02 | 1.0E+01 | -- | 9.0E+03 | 4.0E+03 | 2.6E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **9.0E+03** | **4.0E+03** | **2.6E+02** | **--** |
| Barium | 0 | -- | -- | 2.0E+03 | -- | -- | -- | 5.3E+04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.3E+04** | **--** |
| Benzene C | 0 | -- | -- | 2.2E+01 | 5.1E+02 | -- | -- | 5.8E+02 | 1.3E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.8E+02** | **1.3E+04** |
| Benzidine C | 0 | -- | -- | 8.6E-04 | 2.0E-03 | -- | -- | 2.3E-02 | 5.3E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.3E-02** | **5.3E-02** |
| Benzo (a) anthracene C | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 1.0E+00 | 4.7E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+00** | **4.7E+00** |
| Benzo (b) fluoranthene C | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 1.0E+00 | 4.7E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+00** | **4.7E+00** |
| Benzo (k) fluoranthene C | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 1.0E+00 | 4.7E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+00** | **4.7E+00** |
| Benzo (a) pyrene C | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 1.0E+00 | 4.7E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+00** | **4.7E+00** |
| Bis2-Chloroethyl Ether C | 0 | -- | -- | 3.0E-01 | 5.3E+00 | -- | -- | 7.9E+00 | 1.4E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.9E+00** | **1.4E+02** |
| Bis2-Chloroisopropyl Ether | 0 | -- | -- | 1.4E+03 | 6.5E+04 | -- | -- | 3.7E+04 | 1.7E+06 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.7E+04** | **1.7E+06** |
| Bis 2-Ethylhexyl Phthalate C | 0 | -- | -- | 1.2E+01 | 2.2E+01 | -- | -- | 3.2E+02 | 5.8E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.2E+02** | **5.8E+02** |
| Bromoform C | 0 | -- | -- | 4.3E+01 | 1.4E+03 | -- | -- | 1.1E+03 | 3.7E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.1E+03** | **3.7E+04** |
| Butylbenzylphthalate | 0 | -- | -- | 1.5E+03 | 1.9E+03 | -- | -- | 4.0E+04 | 5.0E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.0E+04** | **5.0E+04** |
| Cadmium | 0 | 4.2E+00 | 1.2E+00 | 5.0E+00 | -- | 1.1E+02 | 3.1E+01 | 1.3E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.1E+02** | **3.1E+01** | **1.3E+02** | **--** |
| Carbon Tetrachloride C | 0 | -- | -- | 2.3E+00 | 1.6E+01 | -- | -- | 6.1E+01 | 4.2E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.1E+01** | **4.2E+02** |
| Chlordane C | 0 | 2.4E+00 | 4.3E-03 | 8.0E-03 | 8.1E-03 | 6.3E+01 | 1.1E-01 | 2.1E-01 | 2.1E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **6.3E+01** | **1.1E-01** | **2.1E-01** | **2.1E-01** |
| Chloride | 0 | 8.6E+05 | 2.3E+05 | 2.5E+05 | -- | 2.3E+07 | 6.1E+06 | 6.6E+06 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **2.3E+07** | **6.1E+06** | **6.6E+06** | **--** |
| TRC | 0 | 1.9E+01 | 1.1E+01 | -- | -- | 5.0E+02 | 2.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **5.0E+02** | **2.9E+02** | **--** | **--** |
| Chlorobenzene | 0 | -- | -- | 1.3E+02 | 1.6E+03 | -- | -- | 3.4E+03 | 4.2E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.4E+03** | **4.2E+04** |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | **Most Limiting Allocations** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | **Acute** | **Chronic** | **HH (PWS)** | **HH** |
| Chlorodibromomethane[C] | 0 | -- | -- | 4.0E+00 | 1.3E+02 | -- | -- | 1.1E+02 | 3.4E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.1E+02** | **3.4E+03** |
| Chloroform | 0 | -- | -- | 3.4E+02 | 1.1E+04 | -- | -- | 9.0E+03 | 2.9E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **9.0E+03** | **2.9E+05** |
| 2-Chloronaphthalene | 0 | -- | -- | 1.0E+03 | 1.6E+03 | -- | -- | 2.6E+04 | 4.2E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.6E+04** | **4.2E+04** |
| 2-Chlorophenol | 0 | -- | -- | 8.1E+01 | 1.5E+02 | -- | -- | 2.1E+03 | 4.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.1E+03** | **4.0E+03** |
| Chlorpyrifos | 0 | 8.3E-02 | 4.1E-02 | -- | -- | 2.2E+00 | 1.1E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **2.2E+00** | **1.1E+00** | **--** | **--** |
| Chromium III | 0 | 5.9E+02 | 7.7E+01 | -- | -- | 1.6E+04 | 2.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.6E+04** | **2.0E+03** | **--** | **--** |
| Chromium VI | 0 | 1.6E+01 | 1.1E+01 | -- | -- | 4.2E+02 | 2.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **4.2E+02** | **2.9E+02** | **--** | **--** |
| Chromium, Total | 0 | -- | -- | 1.0E+02 | -- | -- | -- | 2.6E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.6E+03** | **--** |
| Chrysene [C] | 0 | -- | -- | 3.8E-03 | 1.8E-02 | -- | -- | 1.0E-01 | 4.7E-01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E-01** | **4.7E-01** |
| Copper | 0 | 1.4E+01 | 9.3E+00 | 1.3E+03 | -- | 3.7E+02 | 2.5E+02 | 3.4E+04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **3.7E+02** | **2.5E+02** | **3.4E+04** | **--** |
| Cyanide, Free | 0 | 2.2E+01 | 5.2E+00 | 1.4E+02 | 1.6E+04 | 5.8E+02 | 1.4E+02 | 3.7E+03 | 4.2E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **5.8E+02** | **1.4E+02** | **3.7E+03** | **4.2E+05** |
| DDD [C] | 0 | -- | -- | 3.1E-03 | 3.1E-03 | -- | -- | 8.2E-02 | 8.2E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **8.2E-02** | **8.2E-02** |
| DDE [C] | 0 | -- | -- | 2.2E-03 | 2.2E-03 | -- | -- | 5.8E-02 | 5.8E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.8E-02** | **5.8E-02** |
| DDT [C] | 0 | 1.1E+00 | 1.0E-03 | 2.2E-03 | 2.2E-03 | 2.9E+01 | 2.6E-02 | 5.8E-02 | 5.8E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **2.9E+01** | **2.6E-02** | **5.8E-02** | **5.8E-02** |
| Demeton | 0 | -- | 1.0E-01 | -- | -- | -- | 2.6E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **2.6E+00** | **--** | **--** |
| Diazinon | 0 | 1.7E-01 | 1.7E-01 | -- | -- | 4.5E+00 | 4.5E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **4.5E+00** | **4.5E+00** | **--** | **--** |
| Dibenz(a,h)anthracene [C] | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 1.0E+00 | 4.7E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+00** | **4.7E+00** |
| 1,2-Dichlorobenzene | 0 | -- | -- | 4.2E+02 | 1.3E+03 | -- | -- | 1.1E+04 | 3.4E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.1E+04** | **3.4E+04** |
| 1,3-Dichlorobenzene | 0 | -- | -- | 3.2E+02 | 9.6E+02 | -- | -- | 8.4E+03 | 2.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **8.4E+03** | **2.5E+04** |
| 1,4-Dichlorobenzene | 0 | -- | -- | 6.3E+01 | 1.9E+02 | -- | -- | 1.7E+03 | 5.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.7E+03** | **5.0E+03** |
| 3,3-Dichlorobenzidine[C] | 0 | -- | -- | 2.1E-01 | 2.8E-01 | -- | -- | 5.5E+00 | 7.4E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.5E+00** | **7.4E+00** |
| Dichlorobromomethane [C] | 0 | -- | -- | 5.5E+00 | 1.7E+02 | -- | -- | 1.5E+02 | 4.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.5E+02** | **4.5E+03** |
| 1,2-Dichloroethane [C] | 0 | -- | -- | 3.8E+00 | 3.7E+02 | -- | -- | 1.0E+02 | 9.8E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+02** | **9.8E+03** |
| 1,1-Dichloroethylene | 0 | -- | -- | 3.3E+02 | 7.1E+03 | -- | -- | 8.7E+03 | 1.9E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **8.7E+03** | **1.9E+05** |
| 1,2-trans-dichloroethylene | 0 | -- | -- | 1.4E+02 | 1.0E+04 | -- | -- | 3.7E+03 | 2.6E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.7E+03** | **2.6E+05** |
| 2,4-Dichlorophenol | 0 | -- | -- | 7.7E+01 | 2.9E+02 | -- | -- | 2.0E+03 | 7.7E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.0E+03** | **7.7E+03** |
| 2,4-Dichlorophenoxy acetic acid (2,4-D) | 0 | -- | -- | 1.0E+02 | -- | -- | -- | 2.6E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.6E+03** | **--** |
| 1,2-Dichloropropane[C] | 0 | -- | -- | 5.0E+00 | 1.5E+02 | -- | -- | 1.3E+02 | 4.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+02** | **4.0E+03** |
| 1,3-Dichloropropene [C] | 0 | -- | -- | 3.4E+00 | 2.1E+02 | -- | -- | 9.0E+01 | 5.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **9.0E+01** | **5.5E+03** |
| Dieldrin [C] | 0 | 2.4E-01 | 5.6E-02 | 5.2E-04 | 5.4E-04 | 6.3E+00 | 1.5E+00 | 1.4E-02 | 1.4E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **6.3E+00** | **1.5E+00** | **1.4E-02** | **1.4E-02** |
| Diethyl Phthalate | 0 | -- | -- | 1.7E+04 | 4.4E+04 | -- | -- | 4.5E+05 | 1.2E+06 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.5E+05** | **1.2E+06** |
| 2,4-Dimethylphenol | 0 | -- | -- | 3.8E+02 | 8.5E+02 | -- | -- | 1.0E+04 | 2.2E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+04** | **2.2E+04** |
| Dimethyl Phthalate | 0 | -- | -- | 2.7E+05 | 1.1E+06 | -- | -- | 7.1E+06 | 2.9E+07 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.1E+06** | **2.9E+07** |
| Di-n-Butyl Phthalate | 0 | -- | -- | 2.0E+03 | 4.5E+03 | -- | -- | 5.3E+04 | 1.2E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **5.3E+04** | **1.2E+05** |
| 2,4 Dinitrophenol | 0 | -- | -- | 6.9E+01 | 5.3E+03 | -- | -- | 1.8E+03 | 1.4E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.8E+03** | **1.4E+05** |
| 2-Methyl-4,6-Dinitrophenol | 0 | -- | -- | 1.3E+01 | 2.8E+02 | -- | -- | 3.4E+02 | 7.4E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.4E+02** | **7.4E+03** |
| 2,4-Dinitrotoluene [C] | 0 | -- | -- | 1.1E+00 | 3.4E+01 | -- | -- | 2.9E+01 | 9.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.9E+01** | **9.0E+02** |
| Dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin | 0 | -- | -- | 5.0E-08 | 5.1E-08 | -- | -- | 1.3E-06 | 1.3E-06 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E-06** | **1.3E-06** |
| 1,2-Diphenylhydrazine[C] | 0 | -- | -- | 3.6E-01 | 2.0E+00 | -- | -- | 9.5E+00 | 5.3E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **9.5E+00** | **5.3E+01** |
| Alpha-Endosulfan | 0 | 2.2E-01 | 5.6E-02 | 6.2E+01 | 8.9E+01 | 5.8E+00 | 1.5E+00 | 1.6E+03 | 2.3E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **5.8E+00** | **1.5E+00** | **1.6E+03** | **2.3E+03** |
| Beta-Endosulfan | 0 | 2.2E-01 | 5.6E-02 | 6.2E+01 | 8.9E+01 | 5.8E+00 | 1.5E+00 | 1.6E+03 | 2.3E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **5.8E+00** | **1.5E+00** | **1.6E+03** | **2.3E+03** |
| Alpha + Beta Endosulfan | 0 | 2.2E-01 | 5.6E-02 | -- | -- | 5.8E+00 | 1.5E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **5.8E+00** | **1.5E+00** | **--** | **--** |
| Endosulfan Sulfate | 0 | -- | -- | 6.2E+01 | 8.9E+01 | -- | -- | 1.6E+03 | 2.3E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.6E+03** | **2.3E+03** |
| Endrin | 0 | 8.6E-02 | 3.6E-02 | 5.9E-02 | 6.0E-02 | 2.3E+00 | 9.5E-01 | 1.6E+00 | 1.6E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **2.3E+00** | **9.5E-01** | **1.6E+00** | **1.6E+00** |
| Endrin Aldehyde | 0 | -- | -- | 2.9E-01 | 3.0E-01 | -- | -- | 7.7E+00 | 7.9E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.7E+00** | **7.9E+00** |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | **Most Limiting Allocations** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | **Acute** | **Chronic** | **HH (PWS)** | **HH** |
| Ethylbenzene | 0 | -- | -- | 5.3E+02 | 2.1E+03 | -- | -- | 1.4E+04 | 5.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.4E+04** | **5.5E+04** |
| Fluoranthene | 0 | -- | -- | 1.3E+02 | 1.4E+02 | -- | -- | 3.4E+03 | 3.7E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.4E+03** | **3.7E+03** |
| Fluorene | 0 | -- | -- | 1.1E+03 | 5.3E+03 | -- | -- | 2.9E+04 | 1.4E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.9E+04** | **1.4E+05** |
| Foaming Agents | 0 | -- | -- | 5.0E+02 | -- | -- | -- | 1.3E+04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+04** | **--** |
| Guthion | 0 | -- | 1.0E-02 | -- | -- | -- | 2.6E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **2.6E-01** | **--** | **--** |
| Heptachlor [C] | 0 | 5.2E-01 | 3.8E-03 | 7.9E-04 | 7.9E-04 | 1.4E+01 | 1.0E-01 | 2.1E-02 | 2.1E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **1.4E+01** | **1.0E-01** | **2.1E-02** | **2.1E-02** |
| Heptachlor Epoxide [C] | 0 | 5.2E-01 | 3.8E-03 | 3.9E-04 | 3.9E-04 | 1.4E+01 | 1.0E-01 | 1.0E-02 | 1.0E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **1.4E+01** | **1.0E-01** | **1.0E-02** | **1.0E-02** |
| Hexachlorobenzene [C] | 0 | -- | -- | 2.8E-03 | 2.9E-03 | -- | -- | 7.4E-02 | 7.7E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.4E-02** | **7.7E-02** |
| Hexachlorobutadiene [C] | 0 | -- | -- | 4.4E+00 | 1.8E+02 | -- | -- | 1.2E+02 | 4.7E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.2E+02** | **4.7E+03** |
| Hexachlorocyclohexane Alpha-BHC [C] | 0 | -- | -- | 2.6E-02 | 4.9E-02 | -- | -- | 6.9E-01 | 1.3E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.9E-01** | **1.3E+00** |
| Hexachlorocyclohexane Beta-BHC [C] | 0 | -- | -- | 9.1E-02 | 1.7E-01 | -- | -- | 2.4E+00 | 4.5E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.4E+00** | **4.5E+00** |
| Hexachlorocyclohexane Gamma-BHC [C] (Lindane) | 0 | 9.5E-01 | -- | 9.8E-01 | 1.8E+00 | 2.5E+01 | -- | 2.6E+01 | 4.7E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **2.5E+01** | **--** | **2.6E+01** | **4.7E+01** |
| Hexachlorocyclopentadiene | 0 | -- | -- | 4.0E+01 | 1.1E+03 | -- | -- | 1.1E+03 | 2.9E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.1E+03** | **2.9E+04** |
| Hexachloroethane [C] | 0 | -- | -- | 1.4E+01 | 3.3E+01 | -- | -- | 3.7E+02 | 8.7E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.7E+02** | **8.7E+02** |
| Hydrogen Sulfide | 0 | -- | 2.0E+00 | -- | -- | -- | 5.3E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **5.3E+01** | **--** | **--** |
| Indeno (1,2,3-cd) pyrene [C] | 0 | -- | -- | 3.8E-02 | 1.8E-01 | -- | -- | 1.0E+00 | 4.7E+00 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.0E+00** | **4.7E+00** |
| Iron | 0 | -- | -- | 3.0E+02 | -- | -- | -- | 7.9E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.9E+03** | **--** |
| Isophorone [C] | 0 | -- | -- | 3.5E+02 | 9.6E+03 | -- | -- | 9.2E+03 | 2.5E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **9.2E+03** | **2.5E+05** |
| Kepone | 0 | -- | 0.0E+00 | -- | -- | -- | 0.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **0.0E+00** | **--** | **--** |
| Lead | 0 | 1.3E+02 | 1.4E+01 | 1.5E+01 | -- | 3.3E+03 | 3.8E+02 | 4.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **3.3E+03** | **3.8E+02** | **4.0E+02** | **--** |
| Malathion | 0 | -- | 1.0E-01 | -- | -- | -- | 2.6E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **2.6E+00** | **--** | **--** |
| Manganese | 0 | -- | -- | 5.0E+01 | -- | -- | -- | 1.3E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+03** | **--** |
| Mercury | 0 | 1.4E+00 | 7.7E-01 | - - | - - | 3.7E+01 | 2.0E+01 | - - | - - | -- | -- | -- | -- | -- | -- | -- | -- | **3.7E+01** | **2.0E+01** | **- -** | **- -** |
| Methyl Bromide | 0 | -- | -- | 4.7E+01 | 1.5E+03 | -- | -- | 1.2E+03 | 4.0E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.2E+03** | **4.0E+04** |
| Methylene Chloride [C] | 0 | -- | -- | 4.6E+01 | 5.9E+03 | -- | -- | 1.2E+03 | 1.6E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.2E+03** | **1.6E+05** |
| Methoxychlor | 0 | -- | 3.0E-02 | 1.0E+02 | -- | -- | 7.9E-01 | 2.6E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **7.9E-01** | **2.6E+03** | **--** |
| Mirex | 0 | -- | 0.0E+00 | -- | -- | -- | 0.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **0.0E+00** | **--** | **--** |
| Nickel | 0 | 1.9E+02 | 2.1E+01 | 6.1E+02 | 4.6E+03 | 5.0E+03 | 5.6E+02 | 1.6E+04 | 1.2E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **5.0E+03** | **5.6E+02** | **1.6E+04** | **1.2E+05** |
| Nitrate (as N) | 0 | -- | -- | 1.0E+04 | -- | -- | -- | 2.6E+05 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.6E+05** | **--** |
| Nitrobenzene | 0 | -- | -- | 1.7E+01 | 6.9E+02 | -- | -- | 4.5E+02 | 1.8E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.5E+02** | **1.8E+04** |
| N-Nitrosodimethylamine [C] | 0 | -- | -- | 6.9E-03 | 3.0E+01 | -- | -- | 1.8E-01 | 7.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.8E-01** | **7.9E+02** |
| N-Nitrosodiphenylamine [C] | 0 | -- | -- | 3.3E+01 | 6.0E+01 | -- | -- | 8.7E+02 | 1.6E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **8.7E+02** | **1.6E+03** |
| N-Nitrosodi-n-propylamine [C] | 0 | -- | -- | 5.0E-02 | 5.1E+00 | -- | -- | 1.3E+00 | 1.3E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+00** | **1.3E+02** |
| Nonylphenol | 0 | 2.8E+01 | 6.6E+00 | -- | -- | 7.4E+02 | 1.7E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **7.4E+02** | **1.7E+02** | **--** | **--** |
| Parathion | 0 | 6.5E-02 | 1.3E-02 | -- | -- | 1.7E+00 | 3.4E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.7E+00** | **3.4E-01** | **--** | **--** |
| PCB Total [C] | 0 | -- | 1.4E-02 | 6.4E-04 | 6.4E-04 | -- | 3.7E-01 | 1.7E-02 | 1.7E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **3.7E-01** | **1.7E-02** | **1.7E-02** |
| Pentachlorophenol [C] | 0 | 9.6E+00 | 7.4E+00 | 2.7E+00 | 3.0E+01 | 2.5E+02 | 2.0E+02 | 7.1E+01 | 7.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **2.5E+02** | **2.0E+02** | **7.1E+01** | **7.9E+02** |
| Phenol | 0 | -- | -- | 1.0E+04 | 8.6E+05 | -- | -- | 2.6E+05 | 2.3E+07 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.6E+05** | **2.3E+07** |
| Pyrene | 0 | -- | -- | 8.3E+02 | 4.0E+03 | -- | -- | 2.2E+04 | 1.1E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **2.2E+04** | **1.1E+05** |
| Radionuclides | 0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **--** | **--** |
| Gross Alpha Activity (pCi/L) | 0 | -- | -- | 1.5E+01 | -- | -- | -- | 4.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.0E+02** | **--** |
| Beta and Photon Activity (mrem/yr) | 0 | -- | -- | 4.0E+00 | -- | -- | -- | 1.1E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.1E+02** | **--** |
| Radium 226 + 228 (pCi/L) | 0 | -- | -- | 5.0E+00 | -- | -- | -- | 1.3E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+02** | **--** |
| Uranium (ug/l) | 0 | -- | -- | 3.0E+01 | -- | -- | -- | 7.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **7.9E+02** | **--** |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | **Most Limiting Allocations** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | **Acute** | **Chronic** | **HH (PWS)** | **HH** |
| Selenium, Total Recoverable | 0 | 2.0E+01 | 5.0E+00 | 1.7E+02 | 4.2E+03 | 5.3E+02 | 1.3E+02 | 4.5E+03 | 1.1E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **5.3E+02** | **1.3E+02** | **4.5E+03** | **1.1E+05** |
| Silver | 0 | 3.8E+00 | -- | -- | -- | 9.9E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **9.9E+01** | **--** | **--** | **--** |
| Sulfate | 0 | -- | -- | 2.5E+05 | -- | -- | -- | 6.6E+06 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.6E+06** | **--** |
| 1,1,2,2-Tetrachloroethane[C] | 0 | -- | -- | 1.7E+00 | 4.0E+01 | -- | -- | 4.5E+01 | 1.1E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **4.5E+01** | **1.1E+03** |
| Tetrachloroethylene[C] | 0 | -- | -- | 6.9E+00 | 3.3E+01 | -- | -- | 1.8E+02 | 8.7E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.8E+02** | **8.7E+02** |
| Thallium | 0 | -- | -- | 2.4E-01 | 4.7E-01 | -- | -- | 6.3E+00 | 1.2E+01 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.3E+00** | **1.2E+01** |
| Toluene | 0 | -- | -- | 5.1E+02 | 6.0E+03 | -- | -- | 1.3E+04 | 1.6E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+04** | **1.6E+05** |
| Total dissolved solids | 0 | -- | -- | 5.0E+05 | -- | -- | -- | 1.3E+07 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+07** | **--** |
| Toxaphene [C] | 0 | 7.3E-01 | 2.0E-04 | 2.8E-03 | 2.8E-03 | 1.9E+01 | 5.3E-03 | 7.4E-02 | 7.4E-02 | -- | -- | -- | -- | -- | -- | -- | -- | **1.9E+01** | **5.3E-03** | **7.4E-02** | **7.4E-02** |
| Tributyltin | 0 | 4.6E-01 | 7.2E-02 | -- | -- | 1.2E+01 | 1.9E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1.2E+01** | **1.9E+00** | **--** | **--** |
| 1,2,4-Trichlorobenzene | 0 | -- | -- | 3.5E+01 | 7.0E+01 | -- | -- | 9.2E+02 | 1.8E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **9.2E+02** | **1.8E+03** |
| 1,1,2-Trichloroethane[C] | 0 | -- | -- | 5.9E+00 | 1.6E+02 | -- | -- | 1.6E+02 | 4.2E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.6E+02** | **4.2E+03** |
| Trichloroethylene [C] | 0 | -- | -- | 2.5E+01 | 3.0E+02 | -- | -- | 6.6E+02 | 7.9E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.6E+02** | **7.9E+03** |
| 2,4,6-Trichlorophenol [C] | 0 | -- | -- | 1.4E+01 | 2.4E+01 | -- | -- | 3.7E+02 | 6.3E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **3.7E+02** | **6.3E+02** |
| 2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex) | 0 | -- | -- | 5.0E+01 | -- | -- | -- | 1.3E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **1.3E+03** | **--** |
| Vinyl Chloride[C] | 0 | -- | -- | 2.5E-01 | 2.4E+01 | -- | -- | 6.6E+00 | 6.3E+02 | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** | **6.6E+00** | **6.3E+02** |
| Zinc | 0 | 1.2E+02 | 1.2E+02 | 7.4E+03 | 2.6E+04 | 3.2E+03 | 3.3E+03 | 2.0E+05 | 6.9E+05 | -- | -- | -- | -- | -- | -- | -- | -- | **3.2E+03** | **3.3E+03** | **2.0E+05** | **6.9E+05** |

Notes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise
2. Discharge flow is highest monthly average or Form 2C maximum for Industries and design flow for Municipals
3. Metals measured as Dissolved, unless specified otherwise
4. "C" indicates a carcinogenic parameter
5. Regular WLAs are mass balances (minus background concentration) using the % of stream flow entered above under Mixing Information.
   Antidegradation WLAs are based upon a complete mix.
6. Antideg. Baseline = (0.25(WQC - background conc.) + background conc.) for acute and chronic
   = (0.1(WQC - background conc.) + background conc.) for human health
7. WLAs established at the following stream flows: 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens and
   Harmonic Mean for Carcinogens. To apply mixing ratios from a model set the stream flow equal to (mixing ratio - 1), effluent flow equal to 1 and 100% mix.

| Metal | Target Value (SSTV) |
|---|---|
| Antimony | 1.5E+02 |
| Arsenic | 2.6E+02 |
| Barium | 5.3E+04 |
| Cadmium | 1.9E+01 |
| Chromium III | 1.2E+03 |
| Chromium VI | 1.7E+02 |
| Copper | 1.5E+02 |
| Iron | 7.9E+03 |
| Lead | 2.3E+02 |
| Manganese | 1.3E+03 |
| Mercury | 1.2E+01 |
| Nickel | 3.3E+02 |
| Selenium | 7.9E+01 |
| Silver | 4.0E+01 |
| Zinc | 1.3E+03 |

Note: do not use QL's lower than the minimum QL's provided in agency guidance

1/30/2013 10:10:54 AM

Facility = Chesterfield Power Station- Outfall 004
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 264
WLAc = 6.33
Q.L. = 0.2
# samples/mo. = 4
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 9
Variance = 29.16
C.V. = 0.6
97th percentile daily values = 21.9007
97th percentile 4 day average = 14.9741
97th percentile 30 day average= 10.8544
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 12.7718516913252
Average Weekly Limit = 12.7718516913253
Average Monthly Limit = 8.73244351713122

The data are:

9.00

The evaluation above is expressed in mg/L. Because ammonia is a toxicant purposefully introduced to the effluent, an arbitrary datum of 9.00 mg/L is used to force a limitation. The limitation above is more stringent than the 2004 ammonia limitations: 13 mg/L and 19 mg/L, monthly average and daily max, respectively. Consequently, the more stringent limitations are applied in this reissuance (monthly average: 8.73 mg/L; daily max: 12.8 mg/L).

12/7/2011 2:43:10 PM

Facility = Chesterfield Power Station- Outfall 004
Chemical = chlorides
Chronic averaging period = 4
WLAa = 23000000
WLAc = 6100000
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 118320
Variance = 5039864
C.V. = 0.6
97th percentile daily values = 287921.
97th percentile 4 day average = 196859.
97th percentile 30 day average= 142700.
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

118320

The evaluation above is expressed in µg/L. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

12/7/2011 2:24:02 PM

Facility = Chesterfield Power Station- Outfall 004
Chemical = Dissolved Arsenic
Chronic averaging period = 4
WLAa = 9000
WLAc = 4000
Q.L. = 10
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 41
Variance = 605.16
C.V. = 0.6
97th percentile daily values = 99.7701
97th percentile 4 day average = 68.2153
97th percentile 30 day average= 49.4481
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

41

The evaluation above is expressed in µg/L. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

12/7/2011 2:25:24 PM

Facility = Chesterfield Power Station- Outfall 004
Chemical = Dissolved Cadmium
Chronic averaging period = 4
WLAa = 110
WLAc = 31
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 1.1
Variance = .4356
C.V. = 0.6
97th percentile daily values = 2.67675
97th percentile 4 day average = 1.83016
97th percentile 30 day average= 1.32665
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

1.10

The evaluation above is expressed in µg/L. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

12/7/2011 3:16:09 PM

Facility = Chesterfield Power Station- Outfall 004
Chemical = dissolved chromium
Chronic averaging period = 4
WLAa = 420
WLAc = 290
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 2
Variance = 1.44
C.V. = 0.6
97th percentile daily values = 4.86683
97th percentile 4 day average = 3.32758
97th percentile 30 day average= 2.41210
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

2 .00

The evaluation above is expressed in µg/L. The dissolved hexavalent chromium (with the most stringent WLA) was used in this analysis to be conservative. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

12/7/2011 2:27:21 PM

Facility = Chesterfield Power Station- Outfall 004
Chemical = Dissolved Copper
Chronic averaging period = 4
WLAa = 370
WLAc = 250
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 8
Variance = 23.04
C.V. = 0.6
97th percentile daily values = 19.4673
97th percentile 4 day average = 13.3103
97th percentile 30 day average= 9.64842
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

8.00

The evaluation above is expressed in µg/L. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

12/7/2011 2:28:42 PM

Facility = Chesterfield Power Station- Outfall 004
Chemical = Dissolved Nickel
Chronic averaging period = 4
WLAa = 5000
WLAc = 560
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 25
Variance = 225
C.V. = 0.6
97th percentile daily values = 60.8354
97th percentile 4 day average = 41.5947
97th percentile 30 day average= 30.1513
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

25.00

The evaluation above is expressed in µg/L. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

12/7/2011 2:38:35 PM

Facility = Chesterfield Power Station- Outfall 004
Chemical = Total Recoverable Selenium
Chronic averaging period = 4
WLAa = 530
WLAc = 130
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 19
Variance = 129.96
C.V. = 0.6
97th percentile daily values = 46.2349
97th percentile 4 day average = 31.6120
97th percentile 30 day average= 22.9150
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

19

The evaluation above is expressed in µg/L.

12/7/2011 2:41:51 PM

Facility = Chesterfield Power Station- Outfall 004
Chemical = dissolved zinc
Chronic averaging period = 4
WLAa = 3200
WLAc = 3300
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 26
Variance = 243.36
C.V. = 0.6
97th percentile daily values = 63.2688
97th percentile 4 day average = 43.2585
97th percentile 30 day average= 31.3573
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

26.00

The evaluation above is expressed in µg/L. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

12/7/2011 2:44:23 PM

Facility = Chesterfield Power Station- Outfall 004
Chemical = tributyltin
Chronic averaging period = 4
WLAa = 12
WLAc = 1.9
Q.L. = 0.01
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = .032
Variance = .000368
C.V. = 0.6
97th percentile daily values = .077869
97th percentile 4 day average = .053241
97th percentile 30 day average= .038593
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.032

The evaluation above is expressed in µg/L. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

12/9/2011 3:44:09 PM

Facility = Chesterfield Power Station-Outfall 005
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 264
WLAc = 6.33
Q.L. = 0.01
# samples/mo. = 4
# samples/wk. = 1

Summary of Statistics:

# observations = 8
Expected Value = .014018
Variance = .000070
C.V. = 0.6
97th percentile daily values = .034112
97th percentile 4 day average = .023323
97th percentile 30 day average= .016906
# < Q.L. = 3
Model used = BPJ Assumptions, Type 1 data

No Limit is required for this material

The data are:

0.06
0
0.07
0.05
0
0
0.01
0.07

The evaluation above is expressed in mg/L. Data used in this analysis were reported in the 2009 application and the last five years of DMRs. All “less than QL” data are treated as zeros. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

12/7/2011 5:32:51 PM

Facility = Chesterfield Power Station-Outfall 005
Chemical = Chlorides
Chronic averaging period = 4
WLAa = 23000000
WLAc = 6100000
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 4840
Variance = 8433216
C.V. = 0.6
97th percentile daily values = 11777.7
97th percentile 4 day average = 8052.74
97th percentile 30 day average= 5837.29
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

4840

The evaluation above is expressed in µg/L. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

12/7/2011 5:56:22 PM

Facility = Chesterfield Power Station- Outfall 005
Chemical = Total Recoverable Selenium
Chronic averaging period = 4
WLAa = 530
WLAc = 130
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 6
Variance = 12.96
C.V. = 0.6
97th percentile daily values = 14.6005
97th percentile 4 day average = 9.98274
97th percentile 30 day average= 7.23631
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

6

The evaluation above is expressed in µg/L. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

12/7/2011 5:26:01 PM

Facility = Chesterfield Power Station-Outfall 005
Chemical = Dissolved Arsenic
Chronic averaging period = 4
WLAa = 9000
WLAc = 4000
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 5
Variance = 9
C.V. = 0.6
97th percentile daily values = 12.1670
97th percentile 4 day average = 8.31895
97th percentile 30 day average= 6.03026
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

5.00

The evaluation above is expressed in µg/L. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

12/7/2011 5:36:27 PM

Facility = Chesterfield Power Station
Chemical = Tributyltin
Chronic averaging period = 4
WLAa = 12
WLAc = 1.9
Q.L. = 0.01
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = .03
Variance = .000324
C.V. = 0.6
97th percentile daily values = .073002
97th percentile 4 day average = .049913
97th percentile 30 day average= .036181
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.030

The evaluation above is expressed in µg/L. As shown, reasonable potential to violate the in stream WQS does not exist. Consequently, a limitation is not needed at this time.

d. Ammonia Limitations

In order to comply with Nitrogen Oxide (NOx) emission requirements under the Clean Air Act (CAA), Dominion has installed state-of-the-art Selective Catalytic Reduction (SCR) technology on generating units 4, 5 and 6. The SCRs became operational in 2002 (Unit 5), 2003 (Unit 4), and 2004 (Unit 6). SCR is a post combustion process where ammonia is injected into the flue gas in the presence of a catalyst and reacts with the NOx to form molecular nitrogen and water, which are emitted to the air. The catalyst (vanadium pentoxide) is used to facilitate the chemical reaction. Unreacted ammonia is carried with the flue gases through the duct system and may become deposited on fly ash as ammonium bisulfate. The ammoniated fly ash is subsequently collected by electrostatic precipitators, is mixed with water from the James River to form a sluice, and is then conveyed to the station's old ash pond. At the pH of the sluice water (typically approximately neutral) all of the ammonia associated with the fly ash is expected to dissolve into the sluice water. Following settling of the ash, the remaining water is discharged through Outfall 004 to Farrar Gut, which is a tributary to the James River.

A Letter of Agreement (LOA) between DEQ and Virginia Power became effective on June 14, 2002 authorizing use of the SCR on Unit 4. A monitoring action level of 41 kg/d daily maximum of ammonia was established on Outfall 004. The LOA has a term of one year. In October 2003 a Consent Special Order was executed with ammonia limitations for Outfall 004 of 34.1 kg/d monthly average and 68.2 kg/d daily maximum. It was anticipated that those limitations would be adequate for the operation of the SCRs on Units 4, 5 and 6.

Soon after the SCR on Unit 4 went into operation, it was observed that the Outfall 004 discharges of ammonia had reached the limitations established in the Consent Order. Virginia Power realized that a mistake had been made in estimating the amount of nitrogen that would be in the ammonia form in the ash pond. Projecting all three SCRs in operation, Virginia Power requested that an ammonia limitation be included in the 2004 permit of 520 lbs/day (236 kg/d) monthly average based on the highest one-day projection. To support that request, Dr. Wu-Seng Lung at the University of Virginia modeled the proposed discharge using the Richmond Crater 208 model. Dr. Lung concluded that the proposed discharge of ammonia would cause insignificant increases in ammonia in the main channel of the James River. He also concluded that the water quality standards for ammonia would not be exceeded in the James. A copy of Dr. Lung's report and comments by DEQ staff are provided in **Attachment 5.f**. The requested loading was applied as a daily maximum limitation in the Special Consent Order. Staff elected to establish the limitation in the Consent Order rather than the permit so that a more appropriate limitation for inclusion in the permit could be calculated after data that reflect actual operation of all three SCRs had been collected. The Consent Order was executed May 28, 2005 and terminated May 1. 2007.

As noted above the third SCR went online in 2004 and data on Outfall 004 has been collected over the 2004 permit cycle. The data are summarized in **Attachment 4**. In addition, Dominion has since installed Flue Gas Desulfurization for Sulfur Dioxide (SO2) as required for Units 5 and 6 by Dominion's Consent Decree with EPA before 2012 and 2010, respectively. The FGD wet scrubbing process will capture any unreacted ammonia not captured by the SCR that would otherwise exit through the stack. The ammonia is then concentrated by evaporation in the FGD and discharged through the FGD blowdown stream. This contribution is reflected in the data collected since installation (Unit 6 online April 2008, Unit 5 online May 2011, Units 3 and 4 online December 2011).

The VPDES Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay was issued in 2007. At Dominion's request, Chesterfield Power Station was recognized as a significant discharger and assigned a loading in the WQMP. The loadings assigned (352,036 lbs/year TN & 210 lbs/year TP) represent the net loadings contributed by Outfalls 004 and 005. These loadings are regulated through the Nutrient General Permit (VAN040086), which assigns a combined loading to Outfalls 004 and 005. Ammonia is indirectly controlled through the TN allocation implemented in the General Permit. Consequently, a separate ammonia loading limitation is not needed in the individual permit. Ammonia toxicity is separately evaluated through the reasonable potential analyses at each outfall as described in the preceding attachments.

# 2004

## Ammonia-N Waste Load Allocation

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Facility | | VaP -- C 004 | | | | | |
| Permit No. | | VA0004146 | Enter facility info here | | | | |
| Effluent pH | | 8.0 | | | | | |
| Effluent temperature | | 55.6 | | MIN | 0.20 | 2.85 | 0.20 |
| Effluent Flow | | 13.5 | | MAX | 0.20 | | |
| Stream flow | 1Q10 | 719.5 | | | | | |
| | 30Q10 | 719.5 | | | | | |
| Acute Mix | | 100 | | | | | |
| Chronic Mix | | 100 | | | | | |

| Ammonia Acute Criteria | Criteria | WLAa |
|---|---|---|
| Without Trout | 8.41 | 456.50 |
| With Trout | 5.62 | 304.88 |

Use this data to calculate NH3 limits

| Ammonia Chronic Criteria | | WLAc |
|---|---|---|
| Without Fish | 0.17 | 9.35 |
| With fish | 0.17 | 9.35 |

*Note:*

| | | |
|---|---|---|
| *Acute without trout equation* | = | *0.411/(1+10^(7.204-pH)) + 58.4/(1+10^(pH-7.204))* |
| *Acute with trout equation* | = | *0.275/(1+10^(7.204-pH)) + 39.0/(1+10^(pH-7.204))* |
| *Chronic without fish* | = | *[0.0577/(1+10^(7.688-pH)) + 2.487/(1+10^((pH-7.688))] x MAX* |
| *Chronic with fish* | = | *[0.0577/(1+10^(7.688-pH)) + 2.487/(1+10^((pH-7.688))] x MIN* |

*where MIN = the lesser of 2.85 or 1.45*10^(0.028*(25-T))*
*and MAX = 1.45*10^(0.028*(25-T))*

2004

```
Facility  =  VaP -- Chesterfield   Outfall 004
Chemical  =  Ammonia
Chronic averaging period  =  30
WLAa    =  456.5
WLAc    =  9.35
Q.L.      =  .2
# samples/mo.  =  4
# samples/wk.  =  1

Summary of Statistics:

# observations  =  1
Expected Value  =  4.6
Variance       =  7.6176
C.V.           =  0.6
97th percentile daily values  =  11.1937
97th percentile 4 day average  =  7.65343
97th percentile 30 day average  =  5.54784
# < Q.L.       =  0
Model used     =  BPJ Assumptions, type 2 data
```

**No Limit is required for this material**

The data are:

4.6

4.6 mg/L is the calculated concentration at a flow of 13.5 MGD (daily maximum from DMRs) and a loading of 236 kg/d (loading requested by Virginia Power).

# 2004

Facility = VaP -- Chesterfield Outfall 004
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 456.5
WLAc = 9.35
Q.L. = .2
# samples/mo. = 4
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 8
Variance = 23.04
C.V. = 0.6
97th percentile daily values = 19.4673
97th percentile 4 day average = 13.3103
97th percentile 30 day average = 9.64842
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

**A limit is needed based on Chronic Toxicity**

**Maximum Daily Limit = 18.8652153734425**
Average Weekly limit = 18.8652153734425
**Average Monthly Limit = 12.8986329992381**

The data are:

8

8 mg/L was used to force limitations. 8 mg/L is a totally arbitrary concentration; higher concentrations would result in the same limitations. Limitations were forced so that the permit will contain limitations protective of the water quality standards for ammonia.

e. Total Phosphorus

Outfalls 001 – 003 were assigned Total Phosphorus limitations several permit cycles ago in accordance with the Policy for Nutrient Enriched Waters (VR 680-14-02, 1990). The James River was designated as a Nutrient Enriched Water in the Water Quality Standards, but this designation has since been repealed. The regulation for Nutrient Enriched Waters and Dischargers within the Chesapeake Bay Watershed (9VAC25-40) subsequently promulgated in 2005, excludes noncontact cooling water and storm water from the definition of “point source dischargers.” Outfalls 001-003 discharge non-contact cooling water, which represents zero net addition of nutrients to the receiving stream. GM07-2008 Amendment 2 outlines conditions under which it is appropriate to remove NEW based Total Phosphorus limitations from individual permits of non-significant industrial facilities. Documentation that Outfalls 001-003 meet these criteria is as follows:

1) The limit is technology-based;
2) 9VAC25-40-30-D exempts facilities located in the Chesapeake Bay watershed from this limit;
3) The facility did not install treatment in order to comply with the limit;
4) The facility has not undertaken any process or site management changes in order to comply with the limit, and
5) The discharges from Outfalls 001-003 do not contribute to this facility being a significant discharger. At Dominion’s request, Chesterfield Power Station was recognized as a significant discharger and assigned a loading in the WQMP. The loadings assigned (352, 036 lbs/day TN & 210 lbs/day TP) represent the net loadings contributed by Outfalls 004 and 005. These loadings are regulated through the Nutrient General Permit (VAN040086), which assigns a combined loading to Outfalls 004 and 005. Background contributions from the non-contact cooling water outfalls 001-003 are not addressed in the GP coverage. Monitoring over the past three years indicates that the TP concentrations observed at Outfalls 001-003 are well below the limitation of 2.0 mg/L.
6) In any subsequent expansion or process modification resulting in discharged annual *net* waste loads at or above 2,300 pounds per year of TN or 300 lbs/year of TP for Outfalls 001-003, the facility will register these outfalls for WGP coverage and will have to fully offset any nutrient contribution.

Consequently, TP limitations on Outfalls 001-003 will be removed in this permit reissuance.

Outfalls 004 and 005 will continue to be limited for TP and compliance with the loadings assigned in the WQMP will be regulated through the Nutrient Trading General Permit.

f. Modeling Associated with SCR addition

i. Report from Dr. Wu-Seng Lung titled "Modeling Water Quality Impact of Dominion's Chesterfield Power Station" dated November 25, 2003.
ii. Email from Jennifer Palmore dated January 14, 2004.
iii. Email from Allan Brockenbrough dated January 20, 2004.

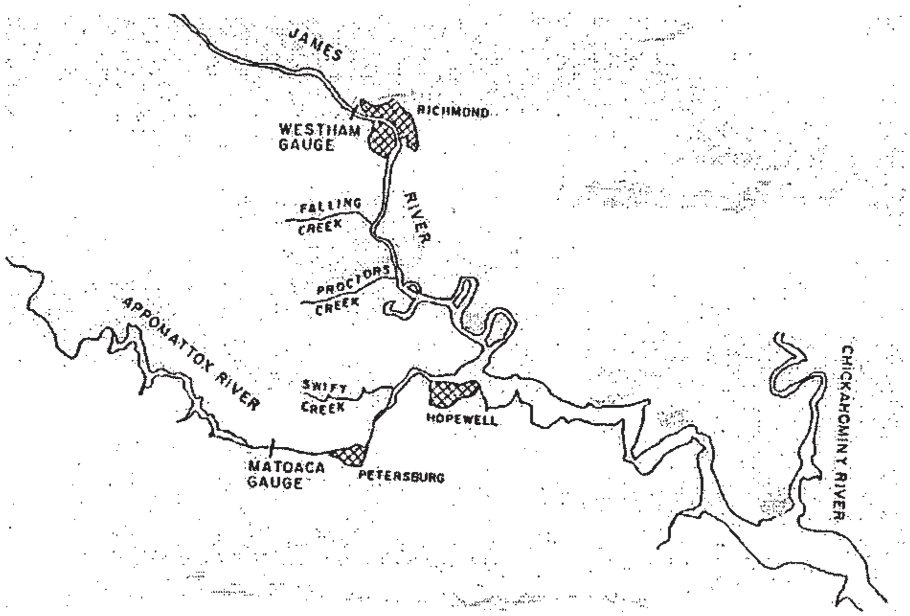
# MODELING WATER QUALITY IMPACT

# OF

# DOMINION'S CHESTERFIELD POWER STATION

**Submitted to**
**Dominion Generation**

**ATTN: Mr. Kenneth Roller**




**Submitted by**

**Wu-Seng Lung, PhD, PE**

**November 25, 2003**

# EXECUTIVE SUMMARY

Due to air pollution control requirements, Dominion's Chesterfield Power Station, located on the Upper James River Estuary near Hopewell, VA, will be installing air emission control technology (Selective Catalytic Reduction, SCR) that may incidentally contribute additional loads of ammonia and nitrate nitrogen into the river. A modeling study was conducted to assess the impact of the Dominion's Chesterfield Power Station on the receiving water quality following the implementation of SCR.

Water quality management of the Upper James River Estuary is based on the Richmond-Crater Water Quality Management Plan (RCWQMP) developed in 1989 by the Virginia State Water Control Board. Wasteload allocations for 15 major point sources along the Upper James River Estuary were developed by RCWQMP using a water quality model, JMSRV. In this study, JMSRV was used to assess the water quality impact. The model simulations were designed to address the following questions:

1. What are the ammonia and nitrate concentrations in the receiving water following the installation of air emission control technology at Dominion's Chesterfield Power Station?
2. Would the maximum allowable ammonia levels in the receiving water be maintained with the projected ammonia loads from Dominion's Chesterfield Power Station?
3. Can the dissolved oxygen standard of 5 mg/L still be met in the Upper James Estuary?
4. What would additional algal biomass (in chlorophyll *a*) be under the projected nitrogen loads (i.e., eutrophication impact)?

Model results presented in this report show very insignificant changes in ammonia and nitrate concentrations in the receiving water with projected nitrogen loads from Dominion's Chesterfield Power Station. Most importantly, the ammonia and dissolved oxygen standards will continue to be met in the Upper James River Estuary under the proposed loading scenario. Further, the impact on eutrophication is also insignificant.

## Modeling Water Quality Impact of Dominion's Chesterfield Power Station[1]

### Introduction and Purpose

Due to air pollution control requirements, Dominion's Chesterfield Power Station, located on the James River Estuary near Hopewell, VA, will be installing air emission control technology that may incidentally contribute additional loads of ammonia and nitrite/nitrate nitrogen into the Upper James Estuary. While the additional nitrogen loads may cause a slight increase in the inorganic nitrogen concentrations in the James River Estuary immediately below the plant outfall, the primary focus is the impact on the dissolved oxygen levels and ammonia toxicity in the receiving water.

At the present time, wasteload allocations (WLA) in the Upper James Estuary (Figure 1) are based on the Richmond-Crater Water Quality Management Plan (RCWQMP) developed in 1989. Under that Plan, carbonaceous biochemical oxygen demand (CBOD) and nutrient loads from 15 major point sources along the Upper James Estuary and the Appomattox River are allocated for years 1990, 2000, and 2010 using a water quality model, JMSRV, calibrated by HydroQual, Inc. (1986).

The purpose of this modeling study is to quantify the effect of the increased nitrogen loads from Dominion's Chesterfield Power Station on dissolved oxygen and ammonia toxicity in the Upper James Estuary using JMSRV. The model results will be submitted to the Virginia Department of the Environmental Quality (VDEQ) as technical support information for the Dominion's Chesterfield Power Station's permit renewal.

### Potential Water Quality Impact

This water quality modeling study is designed to address the following questions:

1. What are the ammonia and nitrate concentrations in the receiving water following the installation of air emission control technology at Dominion's Chesterfield Power Station?
2. Would the maximum allowable ammonia levels in the receiving water be maintained with the projected ammonia loads from Dominion's Chesterfield Power Station?
3. Can the dissolved oxygen standard of 5 mg/L still be met in the Upper James Estuary?
4. What would additional algal biomass (in chlorophyll *a*) be under the projected nitrogen loads (i.e., eutrophication impact)?

Essentially, would the dissolved oxygen and ammonia standards in the ambient water be met under the proposed loading scenario for Dominion's Chesterfield Power Station? In addition, the response of the Upper James River Estuary under the proposed loading scenario is compared with that of the 1990 WLA under RCWQMP to quantify the water quality impact.

[1] Wu-Seng Lung, PhD, PE, Professor of Civil Engineering, University of Virginia

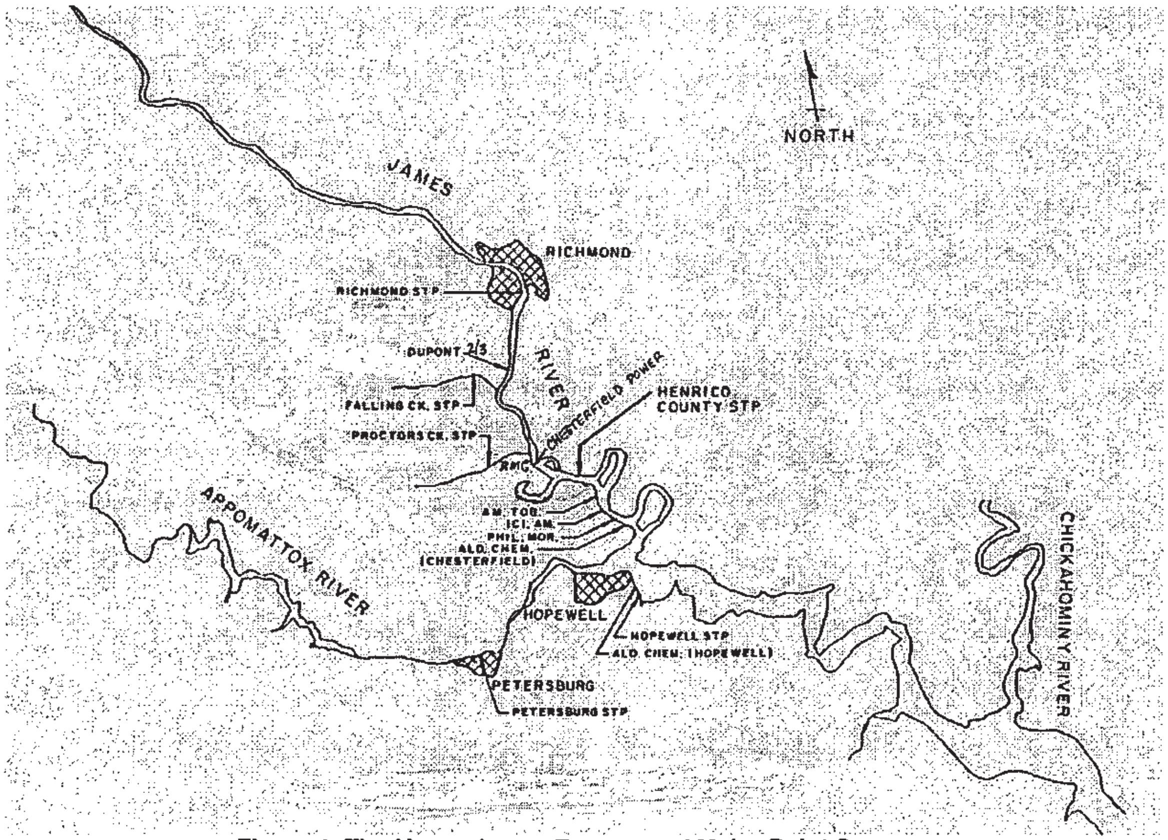


Figure 1. The Upper James Estuary and Major Point Sources

## The RCWQMP and Wasteload Allocations

The legal base of the wasteload allocations for the Upper James Estuary is the Richmond-Crater Water Quality Management Plan published in 1989. The JMSRV model was used in developing these wasteloads under that Plan. A comprehensive description of the model is included in the appendix. Table 1 lists the wasteloads allocated for Dominion's Chesterfield Power Station's VP004 outfall in RCWQMP (Virginia State Water Control Board, 1989).

**Table 1. Wasteload Allocations for Chesterfield Power Station's Outfall VP004**

| Season | Flow (mgd) | Org-N (lb/d) | $NH_3$-N (lb/d) | $NO_3$-N (lb/d) | Total N (lb/d) | Org-P (lb/d) | Inorg-P (lb/d) | Total P (lb/d) | $CBOD_u$ (lb/d) | DO (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| Summer | 8.70 | 36 | 6[a] | 157[b] | 199 | 3 | 1 | 4 | 189 | 5.8 |
| Winter | 8.70 | 9 | 11[c] | 19[d] | 39 | 5 | 2 | 7 | 189 | 5.8 |

a. equivalent to an ammonia concentration of 0.1 mg/L
b. equivalent to a nitrate concentration of 2.2 mg/L
c. equivalent to an ammonia concentration of 0.2 mg/L
d. equivalent to a nitrate concentration of 0.3 mg/L

Note that loading rates are expressed in lb/d except dissolved oxygen where concentrations are in mg/L in the input data file to run the JMSRV model. Total phosphorus concentrations from all 15 major point sources are required to meet the 2-mg/L effluent limit.

**Baseline Model Results**

Model results of the 1990 WLA (from Table 1) are re-generated in this study as the baseline condition. Both summer and winter hydrologic and environmental conditions for the JMSRV model used in the 1990 WLA analysis are adopted in this regeneration run. Model kinetic coefficients calibrated by HydroQual, Inc. (1986) are also incorporated into the model input data file. The model is run time-variably for 120 days to reach a steady state, which results are summarized as follows.

Figure 2 shows model results for $CBOD_u$, organic nitrogen, ammonia, nitrate, organic phosphorus, inorganic phosphorus, chlorophyll *a*, and dissolved oxygen profiles along the river from Richmond to the junction with the Chickahominy River under the summer low flow condition. These concentration profiles match exactly those obtained with the original wasteload allocations in the RCWQMP (1989). Note that the $CBOD_u$ concentrations in Figure 2 include the oxygen needed to fully oxidize the organic carbon in the algal biomass, thereby resembling the algal biomass (chlorophyll *a*) concentration profile. Perhaps the most significant result is that the minimum dissolved oxygen (DO sag) level is meeting the ambient water quality standard of 5 mg/L.

Also shown in Figure 2 is the maximum allowable ammonia concentration to prevent ammonia toxicity in the ambient water. Ammonia toxicity is caused by unionized ammonia, which in turn is a function of pH and temperature. The maximum allowable ammonia concentration shown is based on the most recent Virginia's surface water quality criteria (VSWCB, 2003). At a pH level of 7.8 and water temperature of 29.81°C in the summer month based on the Technical Support Information (RCWQMP, 1989), the maximum allowable concentration of ammonia nitrogen is 1.18 mg/L. Figure 2 indicates that ammonia concentrations in the Upper James River Estuary are well below 1.18 mg/L under the summer low flow condition.

Figure 2 also shows that the algal biomass (in terms of chlorophyll *a*) concentration reaches a maximum level of 42 μg/L near the junction with the Appomattox River. The decline of the chlorophyll *a* levels below that point is due to the depressed inorganic phosphorus (in the form of orthophosphate) concentrations for algae (Figure 2).

Figure 3 summarizes the model results under the winter condition; again reproducing the model results in the RCWQMP of 1989. The ambient dissolved oxygen standard of 5.0 mg/L is also met and the maximum allowable ammonia concentration of 2.17 mg/L (based on RCWQMP winter pH = 7.8 and temperature = 20.23°C) is not violated. The peak of chlorophyll *a* in the winter months is significantly less than that in the summer due to cooler water temperature and reduced light levels for algae.

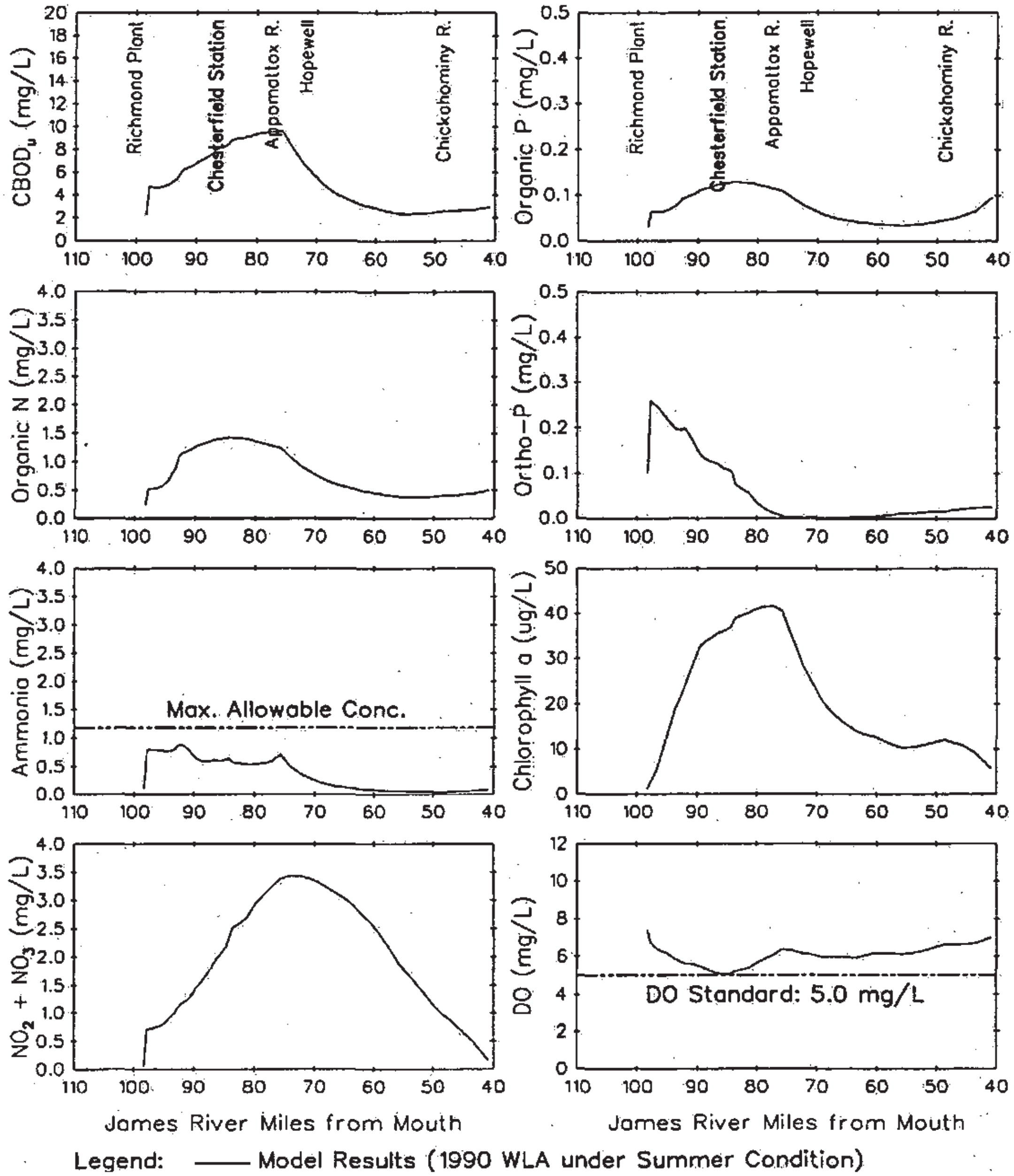



**Figure 2. Baseline Model Results from Summer WLAs for the Upper James River Estuary**

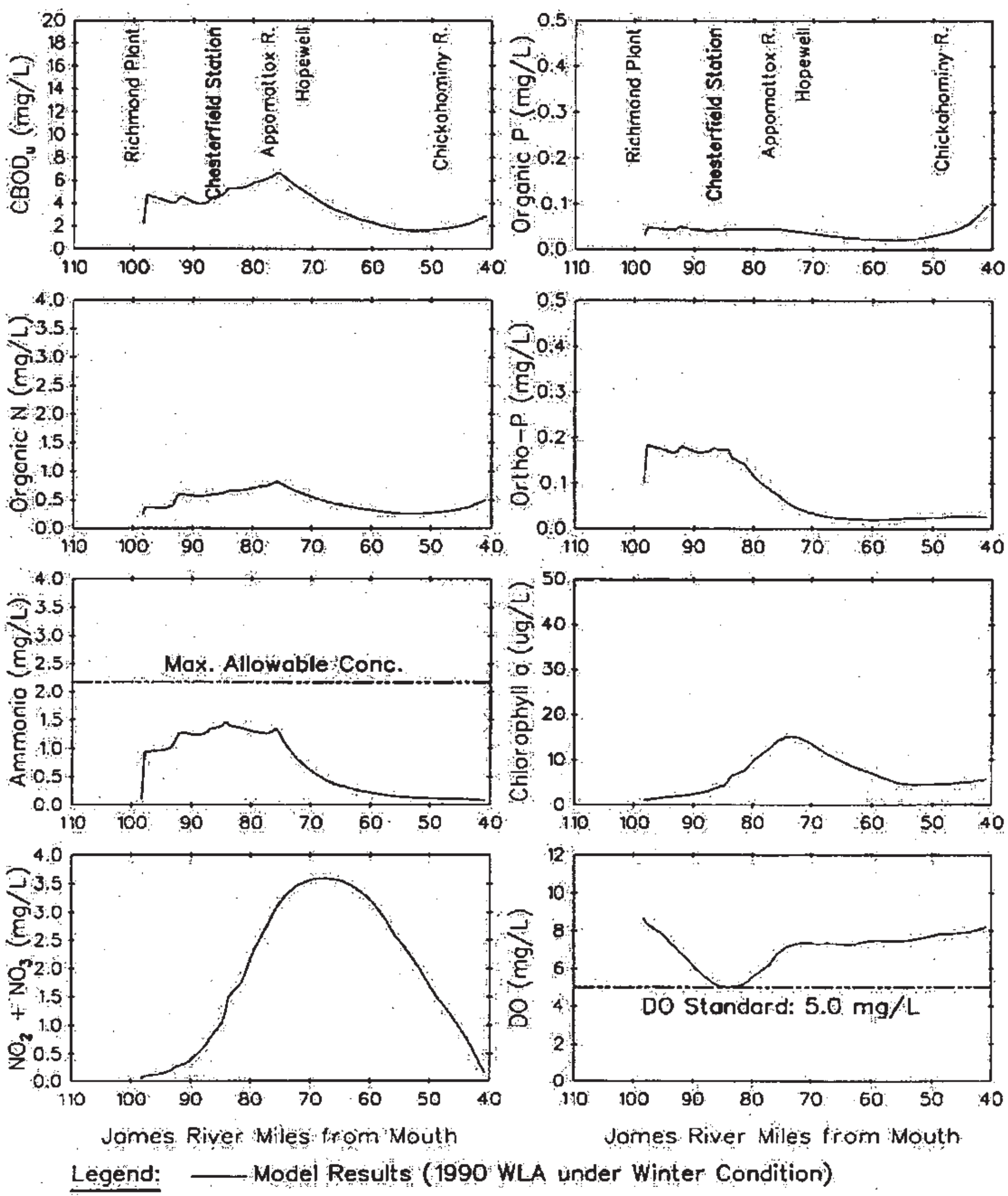



**Figure 3. Baseline Model Results from Winter WLAs for the Upper James River Estuary**

**Impact of the Dominion's Chesterfield Power Station**

The first step in quantifying the impact of Dominion's Chesterfield Power Station is to evaluate the ammonia and nitrate nitrogen loads from the Station. Additional ammonia loadings from Dominion's Chesterfield Power Station may result from the implementation of Selective Catalytic Reduction (SCR) technology to reduce NOx emissions in order to comply with existing air regulatory requirements. Ammonia is used in the SCR process and some residual ammonia may become associated with the fly ash that is generated during the combustion of coal. Consequently, the point source discharge most likely to be impacted by the SCR process is the ash pond discharge Outfall 004, which is designated as VP004 in the RCWQMP.

The proposed ammonia-loading rate for Dominion's Chesterfield Power Station is 520 lb/day for both summer and winter conditions. The proposed nitrate loading rates are 157 lb/day and 19 lb/day for summer and winter, respectively. The loading rates are converted to concentrations for comparison with the concentrations under the baseline condition 1990 WLA in Table 2.

**Table 2. Loading Scenarios for Dominion's Chesterfield Power Station**

| Scenario | Flow (mgd) | Ammonia (mg/L) | | Nitrate (mg/L) | |
|---|---|---|---|---|---|
| | | summer | winter | summer | winter |
| Baseline condition:1990 WLA | 8.70 | 0.1 | 0.2 | 2.2 | 0.3 |
| Proposed loading condition | 8.70 | 7.2 | 7.2 | 2.2 | 0.3 |

As shown in Table 2, the proposed loading condition has higher ammonia concentrations than the baseline 1990 WLA concentrations while the nitrate loads remain the same as the baseline condition.

Figure 4 compares model results of baseline 1990 WLA and proposed scenario, displaying concentration profiles of ammonia, nitrate, chlorophyll *a*, and dissolved oxygen. As illustrated, the impact of the proposed loading condition on the receiving water quality is insignificant under both summer and winter conditions. First, the dissolved oxygen standard of 5 mg/L is still met under the proposed loading condition.

There is very insignificant increase in ammonia concentrations in the receiving water as additional ammonia is taken up by algae (see the small increase in chlorophyll *a* levels in Figure 4). Because of the increase algal growth, the nitrate concentration levels are slightly lower (see the dashed line in Figure 4) than the 1990 WLA levels.

The results under the winter conditions are similar in that the ammonia and dissolved oxygen standards are met. The result for chlorophyll *a* under the winter condition is even less pronounced so the dashed lines displaying the model results of water quality impact cannot be distinguished from the results of the 1990 wasteload allocations (Figure 4). Algal growth in the wintertime is significantly minimized so the nitrate concentrations in the receiving water show a slight increase, compared with the 1990 WLA levels.

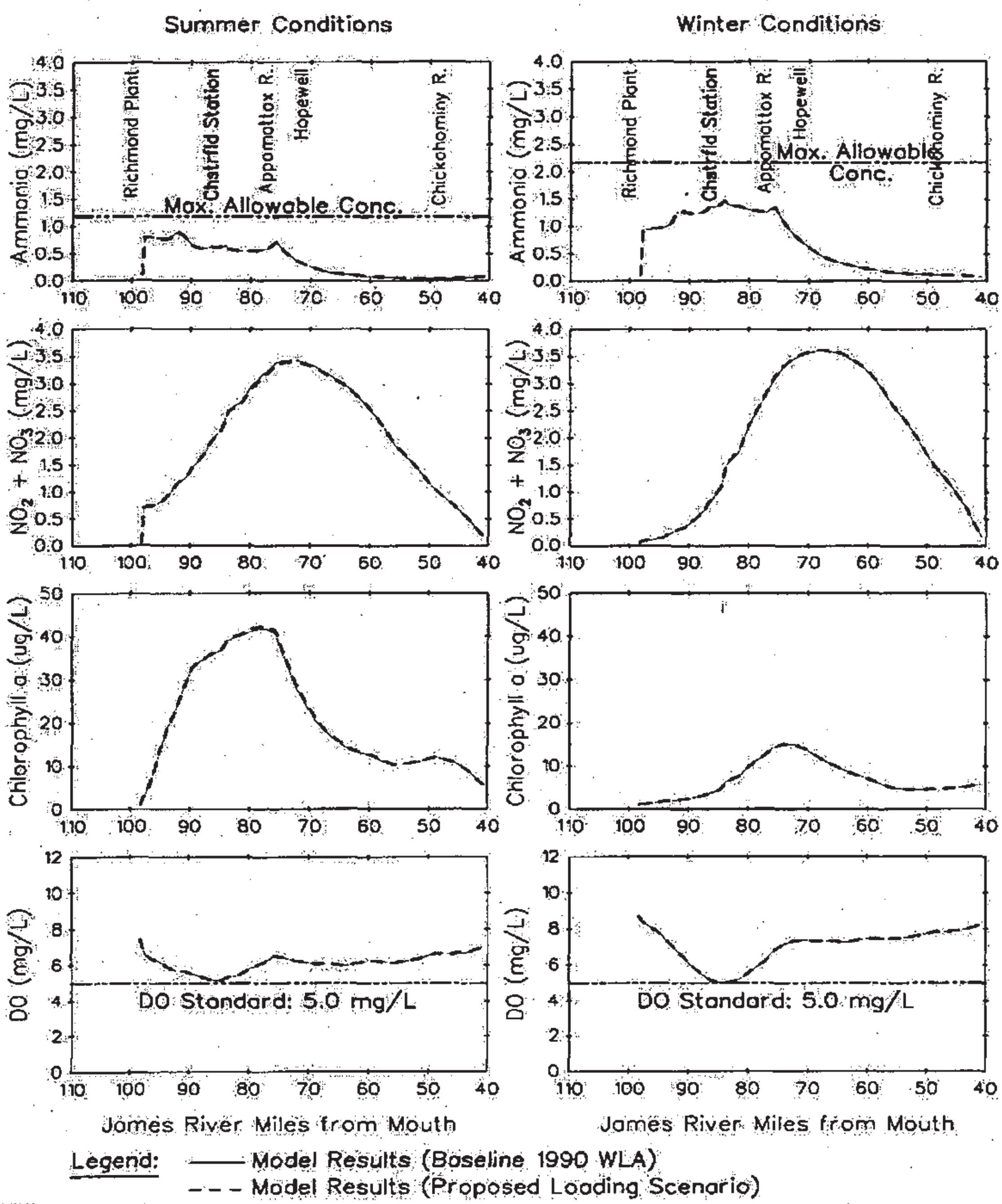



**Figure 4. Model Projection Results – Baseline 1990 WLA and Proposed Scenario**

## Summary and Conclusions

The JMSRV model was used to assess the water quality impact of Dominion's Chesterfield Power Station under future operation conditions. Model results show that the proposed increase in nitrogen loads from the Station's outfall would yield insignificant increases in ammonia concentrations in the Upper James River Estuary under summer conditions. The ambient ammonia concentrations in the receiving water would be below the maximum allowable ammonia levels. There would be no impact on the dissolved oxygen levels in the receiving water, still meeting the DO standard of 5 mg/L. The impact on eutrophication in the receiving water is also insignificant. Water quality impact during the winter months would even be less pronounced.

It should be pointed out that the modeling analysis in this study has yielded conservative results. Point source nutrient loads to the Upper James River Estuary have decreased significantly since 1990 following the implementation of a number of nutrient control strategies such as biological nitrogen removal at municipal wastewater treatment plants. The model results in this study have shown insignificant impact of the Dominion's Chesterfield Power Station on the water quality of the Upper James River Estuary. One can therefore reasonably argue that the ambient ammonia concentration under the proposed loading condition would be comfortably below the maximum levels allowed in the Upper James River Estuary.

## References Cited

Brendel, G.F., Bonetti, J.E., Rathbone, R.F., and Frey, R.N., 2000. Investigation of Ammonia Adsorption on Fly Ash Due to Installation of Selective Catalytic Reduction Systems. Technical report prepared with the support or the U.S. Department of Energy, National Energy Technology Laboratory, through its Cooperative Agreement No. DE-FC26-98FT40028 with West Virginia University Research Corporation, and with the support of Dominion Generation.

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Lung, W.S. 1986. Assessing Phosphorus Control in the James River Basin. *Journal of Environmental Engineering*, 112(1):44-60.

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Virginia State Water Control Board, 1989. Richmond-Crater Water Quality Management Plan Technical Support Information. Report prepared by the Piedmont Regional Office, Water Resources Development Section.

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## APPENDIX – The JMSRV Model

The latest version of the JMSRV model was calibrated by HydroQual, Inc. for the Richmond Region Planning District Commission in 1986. The spatial domain of the model for this study is from the reach of the Upper James River downstream of the Fall Line near Richmond to Jamestown Island, below the confluence of the James River with the Chickahominy River. It also includes a 20-mile reach of the Appomattox River between Petersburg and its confluence with the James. Both the James and Appomattox Rivers in the model domain are estuaries under tidal influence. The model has since been adopted to run on PCs by Lung (1986) and has been used to track the fate and transport of point source phosphorus loads in the Upper James Estuary (Lung and Testerman, 1989).

The main stem of the Upper James Estuary is divided into 54 segments. The 20-mile reach of the Appomattox River is divided into 41 segments. There are a total of 95 segments in the model. Fifteen major dischargers (6 municipalities and 9 industries) are included as point source loads to the receiving water.

The model is able to simulate eight water quality constituents in the water column of the Upper James Estuary: $CBOD_u$, organic nitrogen, ammonia nitrogen, nitrite/nitrate nitrogen, organic phosphorus, orthophosphate, chlorophyll *a*, and dissolved oxygen. The kinetic structure of the model is shown in Figure 5.

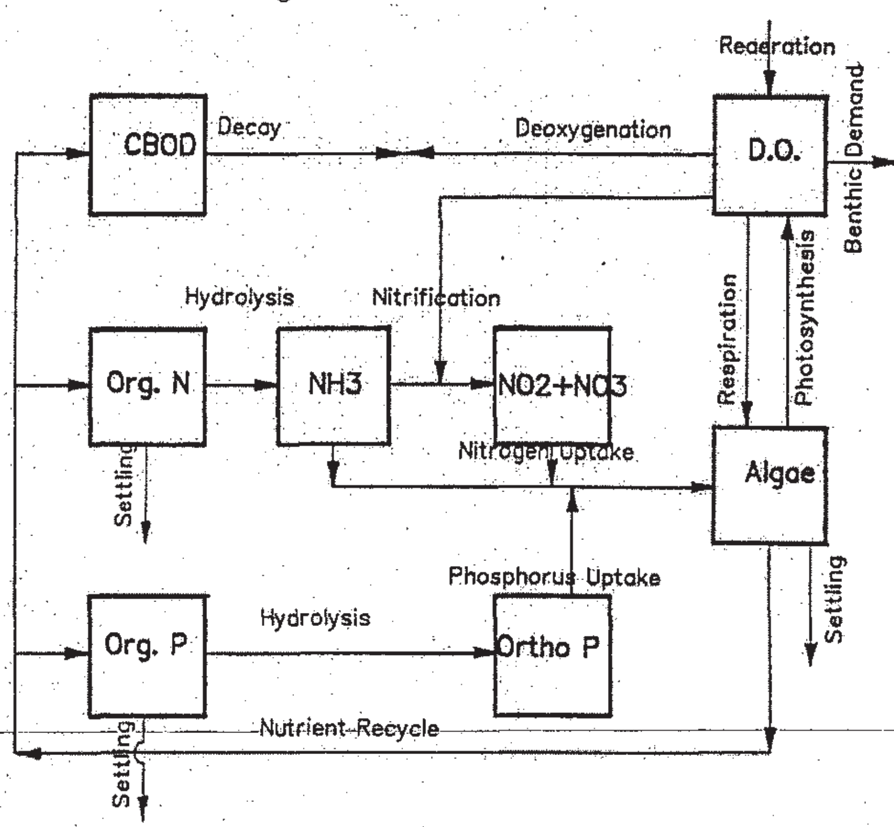


**Figure 5. Water Column Kinetics in the Upper James River Model**

## Jenkins,Ray

**From:** Palmore,Jennifer
**Sent:** Wednesday, January 14, 2004 4:15 PM
**To:** Jenkins,Ray
**Cc:** Alling,Mark; Linderman,Curtis; Brockenbrough,Allan
**Subject:** Dominion VA Power

I have reviewed the submissions from Virginia Power received December 8, 2003. Included were the reports *Modeling Water Quality Impact of Dominion's Chesterfield Power Station* by Dr. Wu-Seng Lung dated November 25, 2003 and *Thermal Modeling of Chesterfield Power Station on the James River and Farrar Gut, Virginia* by Hydroqual dated November 7, 2003.

The water quality report discusses the effect that the additional ammonia load that VA Power has requested would have on ammonia toxicity and dissolved oxygen concentrations in the upper James River estuary. Permits in this reach are currently governed by the Richmond-Crater Interim Water Quality Management Plan, 1989 (RCWQMP) [9 VAC 25-720-60] which evaluated 13 major dischargers using the water quality model JMSRV. VA Power's Chesterfield Power plant was not assigned a waste load allocation. As the RCWQMP is based on the JMSRV, the JMSRV has not been recalibrated since 1986, and Dr. Lung reran the 1990 baseline load to verify that it produced identical results to the original model, I feel that this current modeling approach is an acceptable method in characterizing the effects of the increased ammonia load from VA Power.

The thermal modeling effort was initiated to predict the temperatures that would have occurred in Farrar Gut and the James River during 1998 if the plant had been operating at full permit load conditions of 5.55 BTU/hr for Units 4,5, and 6 and 1.78 BTU/hr for Units 3, 7, and 8. My previous comments regarding the Thermal Modeling report primarily focused on the method of validation. I asked for explanation as to why HydroQual used a combined calibration and validation effort, instead of using the available 1997 and 1999 synoptic survey data to perform a separate validation. HydroQual added narrative in this final report outlining their decision.

In addition, HydroQual further explained the use of the temperature data at JR1 as background temperature. I accept their explanation.

Thank you for the opportunity to review.

Jennifer V. Palmore
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Richmond, VA 23060
(804) 527-5058

## Jenkins,Ray

**From:** Brockenbrough,Allan
**Sent:** Tuesday, January 20, 2004 11:26 AM
**To:** Jenkins,Ray
**Cc:** Palmore,Jennifer; Linderman,Curtis; Alling,Mark
**Subject:** Dominion Power

I have reviewed the reviewed the report entitled *Modeling Water Quality Impact of Dominion's Chesterfield Power Station* by Wu-Seng Lung dated November 25, 2003. The report was submitted to DEQ by letter from Dominion Power dated December 8, 2003.

Dr. Lung has used his pc version on the JMSRV model to predict the impacts of increased Ammonia-N loadings from Dominion Power's outfall 004 as a result of installing Selective Catalytic Reduction (SCR) emission control technology. Use of the SCR technology will significantly reduce NOx air emissions from the facility and increase Ammonia-N in the discharge by approximately 515 lbs/day (summer). Dr. Lung first modeled the 1990 wasteload allocation from the Richmond-Crater Water Quality Management Plan (or 208 Plan) as a baseline condition. He then modeled the baseline condition plus the additional Ammonia from the SCR control devices.

The graphs provided in Figure 4 of the report demonstrate a negligible impact on mainstem James River concentrations of Ammonia, $NO_2 + NO_3$, Chlorophyll a and Dissolved Oxygen. Although the increase in Ammonia levels in the mainstem of the river appears negligible, the conditions under which the water quality criteria was evaluated warrant a closer look. Figure 4 includes the maximum allowable Ammonia concentration (chronic water quality criteria) based on a pH of 7.8 and a summer temperature of 29.81°C. The pH and temperature are from the Technical Support Information for the 208 Plan. The HydroQual report *Thermal Modeling of the Chesterfield Power Station on the James River and Farrar Gut, Virginia (November 7, 2003)* submitted under the same Dominion Power letter of December 8, 2003 includes mainstem synoptic survey temperature values as high as 35.8°C (instantaneous) as well as continuously modeled temperature projections which appear to approach 33°C for 30-day periods during the summer. The HydroQual model demonstrates the effect of the power station operating under full load and 1998 environmental conditions. At a temperature of 33°C and a pH of 7.8, the acute Ammonia criteria falls to 0.97 mg/l which is still well above the peak instream concentration predicted by the JMSRV model for the hottest section of the river (station JR3 in the HydroQual report roughly correspond to river mile 87 in the JMSRV, JR6 is roughly river mile 82). The Lung report therefore is suitable for demonstrating that in the mainstem of the James River there is no significant increase in Ammonia-N concentrations, no Ammonia toxicity and no significant lowering of dissolved oxygen levels due to the addition of the SCR technology. The additional Ammonia load amounts to less than 2% of the total Ammonia allocations in the 208 Plan. For consistency sake, you may consider having the Lung report revised so that maximum allowable Ammonia concentration (the chronic water quality criteria) reflects the temperature conditions predicted by the HydroQual study.

Ammonia toxicity in the vicinity of the outfall should be further evaluated in the Fact Sheet in accordance with GM 00-2011. I have no additional comments on the HydroQual report.

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DEQ - Office of Water Permit Programs
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g. 40 CFR 423

Federal Effluent Guidelines for Steam Electric Power Generating Point Sources section, which may be discharged by a point source subject to the provisions of this subpart after application of the standards of performance for new sources:

[Metric units (kg/kkg of product); English units (lb/1,000 lb of product)]

| Effluent characteristic | Effluent limitations | |
|---|---|---|
| | Maximum for any 1 day | Average of daily values for 30 consecutive days shall not exceed— |
| TSS | 0.35 | 0.18 |
| Total phosphorus (as P) | .56 | .28 |
| Fluoride (as F) | .21 | .11 |
| pH | (1) | (1) |

[1] Within the range 6.0 to 9.5.

### § 422.66 [Reserved]

### § 422.67 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best conventional pollutant control technology.

Except as provided in §§ 125.30 through 125.32, the following limitations establish the quantity or quality of pollutants or pollutant properties, controlled by this section, which may be discharged by a point source subject to the provisions of this subpart after application of the best conventional pollutant control technology:

[Metric units (kg/kkg of product); English units (lb/1,000 lb of product)]

| Effluent characteristic | Effluent limitations | |
|---|---|---|
| | Maximum for any 1 day | Average of daily values for 30 consecutive days shall not exceed— |
| TSS | 0.35 | 0.18 |
| pH | (1) | (1) |

[1] Within the range 6.0 to 9.5.

[51 FR 25000, July 9, 1986]

# PART 423—STEAM ELECTRIC POWER GENERATING POINT SOURCE CATEGORY



AUTHORITY: Secs. 301; 304(b), (c), (e), and (g); 306(b) and (c); 307(b) and (c); and 501, Clean Water Act (Federal Water Pollution Control Act Amendments of 1972, as amended by Clean Water Act of 1977) (the "Act"; 33 U.S.C. 1311; 1314(b), (c), (e), and (g); 1316(b) and (c); 1317(b) and (c); and 1361; 86 Stat. 816, Pub. L. 92–500; 91 Stat. 1567, Pub. L. 95–217), unless otherwise noted.

SOURCE: 47 FR 52304, Nov. 19, 1982, unless otherwise noted.

### § 423.10 Applicability.

The provisions of this part are applicable to discharges resulting from the operation of a generating unit by an establishment primarily engaged in the generation of electricity for distribution and sale which results primarily from a process utilizing fossil-type fuel (coal, oil, or gas) or nuclear fuel in conjunction with a thermal cycle employing the steam water system as the thermodynamic medium.

### § 423.11 Specialized definitions.

In addition to the definitions set forth in 40 CFR part 401, the following definitions apply to this part:

(a) The term *total residual chlorine* (or total residual oxidants for intake water with bromides) means the value obtained using the amperometric method for total residual chlorine described in 40 CFR part 136.

(b) The term *low volume waste sources* means, taken collectively as if from one source, wastewater from all sources except those for which specific limitations are otherwise established in this part. Low volume wastes sources include, but are not limited to:

wastewaters from wet scrubber air pollution control systems, ion exchange water treatment system, water treatment evaporator blowdown, laboratory and sampling streams, boiler blowdown, floor drains, cooling tower basin cleaning wastes, and recirculating house service water systems. Sanitary and air conditioning wastes are not included.

(c) The term *chemical metal cleaning waste* means any wastewater resulting from the cleaning of any metal process equipment with chemical compounds, including, but not limited to, boiler tube cleaning.

(d) The term *metal cleaning waste* means any wastewater resulting from cleaning [with or without chemical cleaning compounds] any metal process equipment including, but not limited to, boiler tube cleaning, boiler fireside cleaning, and air preheater cleaning.

(e) The term *fly ash* means the ash that is carried out of the furnace by the gas stream and collected by mechanical precipitators, electrostatic precipitators, and/or fabric filters. Economizer ash is included when it is collected with fly ash.

(f) The term *bottom ash* means the ash that drops out of the furnace gas stream in the furnace and in the economizer sections. Economizer ash is included when it is collected with bottom ash.

(g) The term *once through cooling water* means water passed through the main cooling condensers in one or two passes for the purpose of removing waste heat.

(h) The term *recirculated cooling water* means water which is passed through the main condensers for the purpose of removing waste heat, passed through a cooling device for the purpose of removing such heat from the water and then passed again, except for blowdown, through the main condenser.

(i) The term *10 year, 24/hour rainfall event* means a rainfall event with a probable recurrence interval of once in ten years as defined by the National Weather Service in Technical Paper No. 40. *Rainfall Frequency Atlas of the United States*, May 1961 or equivalent regional rainfall probability information developed therefrom.

(j) The term *blowdown* means the minimum discharge of recirculating water for the purpose of discharging materials contained in the water, the further buildup of which would cause concentration in amounts exceeding limits established by best engineering practices.

(k) The term *average concentration* as it relates to chlorine discharge means the average of analyses made over a single period of chlorine release which does not exceed two hours.

(l) The term *free available chlorine* shall mean the value obtained using the amperometric titration method for free available chlorine described in *Standard Methods for the Examination of Water and Wastewater*, page 112 (13th edition).

(m) The term *coal pile runoff* means the rainfall runoff from or through any coal storage pile.

**§423.12 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT).**

(a) In establishing the limitations set forth in this section, EPA took into account all information it was able to collect, develop and solicit with respect to factors (such as age and size of plant, utilization of facilities, raw materials, manufacturing processes, non-water quality environmental impacts, control and treatment technology available, energy requirements and costs) which can affect the industry subcategorization and effluent levels established. It is, however, possible that data which would affect these limitations have not been available and, as a result, these limitations should be adjusted for certain plants in this industry. An individual discharger or other interested person may submit evidence to the Regional Administrator (or to the State, if the State has the authority to issue NPDES permits) that factors relating to the equipment or facilities involved, the process applied, or other such factors related to such discharger are fundamentally different from the factors considered in the establishment of the guidelines. On the basis of such evidence or other available information, the Regional

Administrator (or the State) will make a written finding that such factors are or are not fundamentally different for that facility compared to those specified in the Development Document. If such fundamentally different factors are found to exist, the Regional Administrator or the State shall establish for the discharger effluent limitations in the NPDES Permit either more or less stringent than the limitations established herein, to the extent dictated by such fundamentally different factors. Such limitations must be approved by the Administrator of the Environmental Protection Agency. The Administrator may approve or disapprove such limitations, specify other limitations, or initiate proceedings to revise these regulations. The phrase ''other such factors'' appearing above may include significant cost differentials. In no event may a discharger's impact on receiving water quality be considered as a factor under this paragraph.

(b) Any existing point source subject to this subpart must achieve the following effluent limitations representing the degree of effluent reduction by the application of the best practicable control technology currently available (BPT):

(1) The pH of all discharges, except once through cooling water, shall be within the range of 6.0–9.0.

(2) There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid.

(3) The quantity of pollutants discharged from low volume waste sources shall not exceed the quantity determined by multiplying the flow of low volume waste sources times the concentration lised in the following table:

| Pollutant or pollutant property | BPT effluent limitations | |
|---|---|---|
| | Maximum for any 1 day (mg/l) | Average of daily values for 30 consecutive days shall not exceed (mg/l) |
| TSS | 100.0 | 30.0 |
| Oil and grease | 20.0 | 15.0 |

(4) The quantity of pollutants discharged in fly ash and bottom ash transport water shall not exceed the quantity determined by multiplying the flow of fly ash and bottom ash transport water times the concentration listed in the following table:

| Pollutant or pollutant property | BPT effluent limitations | |
|---|---|---|
| | Maximum for any 1 day (mg/l) | Average of daily values for 30 consecutive days shall not exceed (mg/l) |
| TSS | 100.0 | 30.0 |
| Oil and grease | 20.0 | 15.0 |

(5) The quantity of pollutants discharged in metal cleaning wastes shall not exceed the quantity determined by multiplying the flow of metal cleaning wastes times the concentration listed in the following table:

| Pollutant or pollutant property | BPT effluent limitations | |
|---|---|---|
| | Maximum for any 1 day (mg/l) | Average of daily values for 30 consecutive days shall not exceed (mg/l) |
| TSS | 100.0 | 30.0 |
| Oil and grease | 20.0 | 15.0 |
| Copper, total | 1.0 | 1.0 |
| Iron, total | 1.0 | 1.0 |

(6) The quantity of pollutants discharged in once through cooling water shall not exceed the quantity determined by multiplying the flow of once through cooling water sources times the concentation listed in the following table:

| Pollutant or pollutant property | BPT effluent limitations | |
|---|---|---|
| | Maximum concentration (mg/l) | Average concentration (mg/l) |
| Free available chlorine | 0.5 | 0.2 |

(7) The quantity of pollutants discharged in cooling tower blowdown shall not exceed the quantity determined by multiplying the flow of cooling tower blowdown sources times the concentration listed in the following table:

| Pollutant or pollutant property | BPT effluent limitations | |
|---|---|---|
| | Maximum concentration (mg/l) | Average concentration (mg/l) |
| Free available chlorine | 0.5 | 0.2 |

(8) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator or State, if the State has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level or chlorination.

(9) Subject to the provisions of paragraph (b)(10) of this section, the following effluent limitations shall apply to the point source discharges of coal pile runoff:

| Pollutant or pollutant property | BPT effluent limitations |
| --- | --- |
| | Maximum concentration for any time (mg/l) |
| TSS | 50 |

(10) Any untreated overflow from facilities designed, constructed, and operated to treat the volume of coal pile runoff which is associated with a 10 year, 24 hour rainfall event shall not be subject to the limitations in paragraph (b)(9) of this section.

(11) At the permitting authority's discretion, the quantity of pollutant allowed to be discharged may be expressed as a concentration limitation instead of the mass based limitations specified in paragraphs (b)(3) through (7) of this section. Concentration limitations shall be those concentrations specified in this section.

(12) In the event that waste streams from various sources are combined for treatment or discharge, the quantity of each pollutant or pollutant property controlled in paragraphs (b)(1) through (11) of this section attributable to each controlled waste source shall not exceed the specified limitations for that waste source.

(The information collection requirements contained in paragraph (a) were approved by the Office of Management and Budget under control number 2000–0194)

[47 FR 52304, Nov. 19, 1982, as amended at 48 FR 31404, July 8, 1983]

### § 423.13 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best available technology economically achievable (BAT).

Except as provided in 40 CFR 125.30 through 125.32, any existing point source subject to this part must achieve the following effluent limitations representing the degree of effluent reduction attainable by the application of the best available technology economically achievable (BAT).

(a) There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid.

(b)(1) For any plant with a total rated electric generating capacity of 25 or more megawatts, the quantity of pollutants discharged in once through cooling water from each discharge point shall not exceed the quantity determined by multiplying the flow of once through cooling water from each discharge point times the concentration listed in the following table:

| Pollutant or pollutant property | BAT Effluent Limitations |
| --- | --- |
| | Maximum concentration (mg/l) |
| Total residual chlorine | 0.20 |

(2) Total residual chlorine may not be discharged from any single generating unit for more than two hours per day unless the discharger demonstrates to the permitting authority that discharge for more than two hours is required for macroinvertebrate control. Simultaneous multi-unit chlorination is permitted.

(c)(1) For any plant with a total rated generating capacity of less than 25 megawatts, the quantity of pollutants discharged in once through cooling water shall not exceed the quantity determined by multiplying the flow of once through cooling water sources times the concentration listed in the following table:

| Pollutant or pollutant property | BAT effluent limitations | |
| --- | --- | --- |
| | Maximum concentration (mg/l) | Average concentration (mg/l) |
| Free available chlorine | 0.5 | 0.2 |

(2) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator or State, if the State has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level of chlorination.

(d)(1) The quantity of pollutants discharged in cooling tower blowdown shall not exceed the quantity determined by multiplying the flow of cooling tower blowdown times the concentration listed below:

| Pollutant or pollutant property | BAT effluent limitations | |
|---|---|---|
| | Maximum concentration (mg/l) | Average concentration (mg/l) |
| Free available chlorine | 0.5 | 0.2 |

| Pollutant or pollutant property | Maximum for any 1 day – (mg/l) | Average of daily values for 30 consecutive days shall not exceed =(mg/l) |
|---|---|---|
| The 126 priority pollutants (Appendix A) contained in chemicals added for cooling tower maintenance, except: | ([1]) | ([1]) |
| Chromium, total | 0.2 | 0.2 |
| Zinc, total | 1.0 | 1.0 |

[1] No detectable amount.

(2) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator or State, if the State has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level of chlorination.

(3) At the permitting authority's discretion, instead of the monitoring specified in 40 CFR 122.11(b) compliance with the limitations for the 126 priority pollutants in paragraph (d)(1) of this section may be determined by engineering calculations which demonstrate that the regulated pollutants are not detectable in the final discharge by the analytical methods in 40 CFR part 136.

(e) The quantity of pollutants discharged in chemical metal cleaning wastes shall not exceed the quantity determined by multiplying the flow of chemical metal cleaning wastes times the concentration listed in the following table:

| Pollutant or pollutant property | BAT effluent limitations | |
|---|---|---|
| | Maximum for any 1 day (mg/l) | Average of daily values for 30 consecutive days shall not exceed – (mg/l) |
| Copper, total | 1.0 | 1.0 |
| Iron, total | 1.0 | 1.0 |

(f) [Reserved—Nonchemical Metal Cleaning Wastes].

(g) At the permitting authority's discretion, the quantity of pollutant allowed to be discharged may be expressed as a concentration limitation instead of the mass based limitations specified in paragraphs (b) through (e) of this section. Concentration limitations shall be those concentrations specified in this section.

(h) In the event that waste streams from various sources are combined for treatment or discharge, the quantity of each pollutant or pollutant property controlled in paragraphs (a) through (g) of this section attributable to each controlled waste source shall not exceed the specified limitation for that waste source.

(The information collection requirements contained in paragraphs (c)(2) and (d)(2) were approved by the Office of Management and Budget under control number 2040–0040. The information collection requirements contained in paragraph (d)(3) were approved under control number 2040–0033.)

[47 FR 52304, Nov. 19, 1982, as amended at 48 FR 31404, July 8, 1983]

**§423.14 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best conventional pollutant control technology (BCT). [Reserved]**

**§423.15 New source performance standards (NSPS).**

Any new source subject to this subpart must achieve the following new source performance standards:

(a) The pH of all discharges, except once through cooling water, shall be within the range of 6.0–9.0.

(b) There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid.

(c) The quantity of pollutants discharged from low volume waste sources shall not exceed the quantity determined by multiplying the flow of low volume waste sources times the concentration listed in the following table:

| Pollutant or pollutant property | NSPS effluent limitations | |
|---|---|---|
| | Maximum for any 1 day (mg/l) | Average of daily values for 30 consecutive days shall not exceed (mg/l) |
| TSS | 100.0 | 30.0 |
| Oil and grease | 20.0 | 15.0 |

(d) The quantity of pollutants discharged in chemical metal cleaning wastes shall not exceed the quantity determined by multiplying the flow of chemical metal cleaning wastes times the concentration listed in the following table:

| Pollutant or pollutant property | NSPS effluent limitations | |
|---|---|---|
| | Maximum for any 1 day (mg/l) | Average of daily values for 30 consecutive days shall not exceed (mg/l) |
| TSS | 100.0 | 30.0 |
| Oil and grease | 20.0 | 15.0 |
| Copper, total | 1.0 | 1.0 |
| Iron, total | 1.0 | 1.0 |

(e) [Reserved—Nonchemical Metal Cleaning Wastes].

(f) The quantity of pollutants discharged in bottom ash transport water shall not exceed the quantity determined by multiplying the flow of the bottom ash transport water times the concentration listed in the following table:

| Pollutant or pollutant property | NSPS effluent limitations | |
|---|---|---|
| | Maximum for any 1 day (mg/l) | Average of daily values for 30 consecutive days shall not exceed (mg/l) |
| TSS | 100.0 | 30.0 |
| Oil and grease | 20.0 | 15.0 |

(g) There shall be no discharge of wastewater pollutants from fly ash transport water.

(h)(1) For any plant with a total rated electric generating capacity of 25 or more megawatts, the quantity of pollutants discharged in once through cooling water from each discharge point shall not exceed the quantity determined by multiplying the flow of once through cooling water from each discharge point times the concentration listed in the following table:

| Pollutant or pollutant property | NSPS effluent limitations |
|---|---|
| | Maximum concentration (mg/l) |
| Total residual chlorine | 0.20 |

(2) Total residual chlorine may not be discharged from any single generating unit for more than two hours per day unless the discharger demonstrates to the permitting authority that discharge for more than two hours is required for macroinvertebrate control. Simultaneous multi-unit chlorination is permitted.

(i)(1) For any plant with a total rated generating capacity of less than 25 megawatts, the quantity of pollutants discharged in once through cooling water shall not exceed the quantity determined by multiplying the flow of once through cooling water sources times the concentration listed in the following table:

| Pollutant of pollutant property | NSPS effluent limitations | |
|---|---|---|
| | Maximum concentration (mg/l) | Average concentration (mg/l) |
| Free available chlorine | 0.5 | 0.2 |

(2) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator or State, if the State has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level of chlorination.

(j)(1) The quantity of pollutants discharged in cooling tower blowdown shall not exceed the quantity determined by multiplying the flow of cooling tower blowdown times the concentration listed below:

| Pollutant or pollutant property | NSPS effluent limitations | |
|---|---|---|
| | Maximum concentration (mg/l) | Average concentration (mg/l) |
| Free available chlorine | 0.5 | 0.2 |

| Pollutant or pollutant property | Maximum for any 1 day (mg/l) | Average of daily values for 30 consecutive days shall not exceed – (mg/l) |
|---|---|---|
| The 126 priority pollutants (Appendix A) contained in chemicals added for cooling tower maintenance, except: | (1) | (1) |
| Chromium, total | 0.2 | 0.2 |
| Zinc, total | 1.0 | 1.0 |

[1] No detectable amount.

(2) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator or State, if the State has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level of chlorination.

(3) At the permitting authority's discretion, instead of the monitoring in 40 CFR 122.11(b), compliance with the limitations for the 126 priority pollutants in paragraph (j)(1) of this section may be determined by engineering calculations which demonstrate that the regulated pollutants are not detectable in the final discharge by the analytical methods in 40 CFR part 136.

(k) Subject to the provisions of §423.15(l), the quantity or quality of pollutants or pollutant parameters discharged in coal pile runoff shall not exceed the limitations specified below:

| Pollutant or pollutant property | NSPS effluent limitations for any time |
|---|---|
| TSS | Not to exceed 50 mg/l. |

(l) Any untreated overflow from facilities designed, constructed, and operated to treat the coal pile runoff which results from a 10 year, 24 hour rainfall event shall not be subject to the limitations in §423.15(k).

(m) At the permitting authority's discretion, the quantity of pollutant allowed to be discharged may be expressed as a concentration limitation instead of the mass based limitation specified in paragraphs (c) through (j) of this section. Concentration limits shall be based on the concentrations specified in this section.

(n) In the event that waste streams from various sources are combined for treatment or discharge, the quantity of each pollutant or pollutant property controlled in paragraphs (a) through (m) of this section attributable to each controlled waste source shall not exceed the specified limitation for that waste source.

(The information collection requirements contained in paragraphs (h)(2), (i)(2), and (j)(2) were approved by the Office of Management and Budget under control number 2040–0040. The information collection requirements contained in paragraph (j)(3) were approved under control number 2040–0033.)

[47 FR 52304, Nov. 19, 1982, as amended at 48 FR 31404, July 8, 1983]

### § 423.16 Pretreatment standards for existing sources (PSES).

Except as provided in 40 CFR 403.7 and 403.13, any existing source subject to this subpart which introduces pollutants into a publicly owned treatment works must comply with 40 CFR part 403 and achieve the following pretreatment standards for existing sources (PSES) by July 1, 1984:

(a) There shall be no discharge of polychlorinated biphenol compounds such as those used for transformer fluid.

(b) The pollutants discharged in chemical metal cleaning wastes shall not exceed the concentration listed in the following table:

| Pollutant or pollutant property | PSES pretreatment standards |
|---|---|
| | Maximum for 1 day (mg/l) |
| Copper, total | 1.0 |

(c) [Reserved—Nonchemical Metal Cleaning Wastes].

(d)(1) The pollutants discharged in cooling tower blowdown shall not exceed the concentration listed in the following table:

| Pollutant or pollutant property | PSES pretreatment standards |
|---|---|
| | Maximum for any time (mg/l) |
| The 126 priority pollutants (Appendix A) contained in chemicals added for cooling tower maintenance, except: | [1] |
| Chromium, total | 0.2 |
| Zinc, total | 1.0 |

[1] No detectable amount.

(2) At the permitting authority's discretion, instead of the monitoring in 40 CFR 122.11(b), compliance with the limitations for the 126 priority pollutants in paragraph (d)(1) of this section may be determined by engineering calculations which demonstrate that the regulated pollutants are not detectable in the final discharge by the analytical methods in 40 CFR part 136.

### § 423.17 Pretreatment standards for new sources (PSNS).

Except as provided in 40 CFR 403.7, any new source subject to this subpart part which introduces pollutants into a publicly owned treatment works must comply with 40 CFR part 403 and the following pretreatment standards for new sources (PSNS).

(a) There shall be no discharge of polychlorinated biphenyl compounds such as those used for transformer fluid.

(b) The pollutants discharged in chemical metal cleaning wastes shall not exceed the concentration listed in the following table:

| Pollutant or pollutant property | PSNS pretreatment standards |
|---|---|
| | Maximum for 1 day (mg/l) |
| Copper, total | 1.0 |

(c) [Reserved—Nonchemical Metal Cleaning Wastes].

(d)(1) The pollutants discharged in cooling tower blowdown shall not exceed the concentration listed in the following table:

| Pollutant or pollutant property | PSNS pretreatment standards |
|---|---|
| | Maximum for any time (mg/l) |
| The 126 priority pollutants (Appendix A) contained in chemicals added for cooling tower maintenance, except: | |
| Chromium, total | 0.2 |
| Zinc, total | 1.0 |

(2) At the permitting authority's discretion, instead of the monitoring in 40 CFR 122.11(b), compliance with the limitations for the 126 priority pollutants in paragraph (d)(1) of this section may be determined by engineering calculations which demonstrate that the regulated pollutants are not detectable in the final discharge by the analytical methods in 40 CFR part 136.

(e) There shall be no discharge of wastewater pollutants from fly ash transport water.

## APPENDIX A TO PART 423—126 PRIORITY POLLUTANTS

001 Acenaphthene
002 Acrolein
003 Acrylonitrile
004 Benzene
005 Benzidine
006 Carbon tetrachloride (tetrachloromethane)
007 Chlorobenzene
008 1,2,4-trichlorobenzene
009 Hexachlorobenzene
010 1,2-dichloroethane
011 1,1,1-trichloreothane
012 Hexachloroethane
013 1,1-dichloroethane
014 1,1,2-trichloroethane
015 1,1,2,2-tetrachloroethane
016 Chloroethane
018 Bis(2-chloroethyl) ether
019 2-chloroethyl vinyl ether (mixed)
020 2-chloronaphthalene
021 2,4, 6-trichlorophenol
022 Parachlorometa cresol
023 Chloroform (trichloromethane)

024 2-chlorophenol
025 1,2-dichlorobenzene
026 1,3-dichlorobenzene
027 1,4-dichlorobenzene
028 3,3-dichlorobenzidine
029 1,1-dichloroethylene
030 1,2-trans-dichloroethylene
031 2,4-dichlorophenol
032 1,2-dichloropropane
033 1,2-dichloropropylene (1,3-dichloropropene)
034 2,4-dimethylphenol
035 2,4-dinitrotoluene
036 2,6-dinitrotoluene
037 1,2-diphenylhydrazine
038 Ethylbenzene
039 Fluoranthene
040 4-chlorophenyl phenyl ether
041 4-bromophenyl phenyl ether
042 Bis(2-chloroisopropyl) ether
043 Bis(2-chloroethoxy) methane
044 Methylene chloride (dichloromethane)
045 Methyl chloride (dichloromethane)
046 Methyl bromide (bromomethane)
047 Bromoform (tribromomethane)
048 Dichlorobromomethane
051 Chlorodibromomethane
052 Hexachlorobutadiene
053 Hexachloromyclopentadiene
054 Isophorone
055 Naphthalene
056 Nitrobenzene
057 2-nitrophenol
058 4-nitrophenol
059 2,4-dinitrophenol
060 4,6-dinitro-o-cresol
061 N-nitrosodimethylamine
062 N-nitrosodiphenylamine
063 N-nitrosodi-n-propylamin
064 Pentachlorophenol
065 Phenol
066 Bis(2-ethylhexyl) phthalate
067 Butyl benzyl phthalate
068 Di-N-Butyl Phthalate
069 Di-n-octyl phthalate
070 Diethyl Phthalate
071 Dimethyl phthalate
072 1,2-benzanthracene (benzo(a) anthracene
073 Benzo(a)pyrene (3,4-benzo-pyrene)
074 3,4-Benzofluoranthene (benzo(b) fluoranthene)
075 11,12-benzofluoranthene (benzo(b) fluoranthene)
076 Chrysene
077 Acenaphthylene
078 Anthracene
079 1,12-benzoperylene (benzo(ghi) perylene)
080 Fluorene
081 Phenanthrene
082 1,2,5,6-dibenzanthracene (dibenzo(,h) anthracene)
083 Indeno (,1,2,3-cd) pyrene (2,3-o-pheynylene pyrene)
084 Pyrene
085 Tetrachloroethylene
086 Toluene
087 Trichloroethylene
088 Vinyl chloride (chloroethylene)
089 Aldrin
090 Dieldrin
091 Chlordane (technical mixture and metabolites)
092 4,4-DDT
093 4,4-DDE (p,p-DDX)
094 4,4-DDD (p,p-TDE)
095 Alpha-endosulfan
096 Beta-endosulfan
097 Endosulfan sulfate
098 Endrin
099 Endrin aldehyde
100 Heptachlor
101 Heptachlor epoxide (BHC-hexachlorocyclohexane)
102 Alpha-BHC
103 Beta-BHC
104 Gamma-BHC (lindane)
105 Delta-BHC (PCB-polychlorinated biphenyls)
106 PCB–1242 (Arochlor 1242)
107 PCB–1254 (Arochlor 1254)
108 PCB–1221 (Arochlor 1221)
109 PCB–1232 (Arochlor 1232)
110 PCB–1248 (Arochlor 1248)
111 PCB–1260 (Arochlor 1260)
112 PCB–1016 (Arochlor 1016)
113 Toxaphene
114 Antimony
115 Arsenic
116 Asbestos
117 Beryllium
118 Cadmium
119 Chromium
120 Copper
121 Cyanide, Total
122 Lead
123 Mercury
124 Nickel
125 Selenium
126 Silver
127 Thallium
126 Silver
128 Zinc
129 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD)

# PART 424—FERROALLOY MANUFACTURING POINT SOURCE CATEGORY

## Subpart A—Open Electric Furnaces With Wet Air Pollution Control Devices Subcategory

**Attachment 6**

Removal of Outfalls 006-011

# Removal of Outfalls 006-011

May 16, 2012

Background:

Outfalls 006-011 are the screen backwashes for the cooling water intakes. Monitoring performed on these outfalls during the 1997 permit cycle revealed the need to establish effluent limitations. TRC limitations were assigned to Outfalls 006-011 in the 2004 permit reissuance with a four year compliance schedule. In response to the limitations, Dominion developed a plan of compliance to re-plumb the chlorine feed system such that chlorine is introduced after the backwash water is withdrawn from the intake lines. The plumbing project was completed in November 2008. Because the facility did not reopen the permit to remove the limitations, the TRC effluent limits became effective December 10, 2008. The facility has been in compliance with the TRC limitations on each outfall since they became effective.

Dominion's compliance plan was designed to eliminate the pollutant source such that the effluent from Outfalls 006-011 is strictly river water with no additives. Since the compliance plan has been executed, the facility requested removal of Outfalls 006-011 on the basis that the effluent no longer represents the discharge of *pollutants* to state waters and, consequently, does not require permitting. In response to the facility's request, DEQ staff asked for a demonstration that all chlorine feeds were correctly relocated. The enclosed report documents Dominion's effort to make that demonstration.

The current minimum accepted agency Quantification Level (QL) for chlorine is 0.1 mg/L. However, there are methods that can analyze more precisely, and in this case Dominion was requested to demonstrate that chlorine concentrations were <38 µg/L, the limitation in the 2004 permit. As suggested by DEQ, Dominion analyzed for TRC using the HACH Ultra Low Range (ULR) Method 10014, which has a theoretical QL of at least 38 µg/L. As noted in the enclosed report, there were extensive challenges in achieving reliable results at the QL requested. After high variability was observed in the first round of analyses, the facility evaluated the performance of the analytical method by analyzing samples of tap water and ambient James River conditions at a pre-established sampling location.

Based on the evaluation, Dominion concluded the following:

1) Background TRC may be present in the James River upstream of the Power Station intakes (midway through a period of ebb tide).

2) The measured TRC concentrations in the James River varied considerably between the sampling locations and times. Considerable variability was also observed between the effluent TRC concentrations. Sources of variability may include: differences in the concentrations of interfering substances, the loss of chlorine from the sample over time, or the normal variability associated with the analytical method.

3) The average concentration of TRC measured in the intake screen backwash discharges was not significantly different at the 90% confidence level from the average James River background TRC concentration.

DEQ staff reviewed the report and evaluated the analytical results using Cochran's Approximation to the Behrens' Fisher Student's t-Test at a 5% confidence level. The spreadsheet is enclosed and indicates that there is no significant difference between the ambient data and the effluent data.

Outfalls 006-011 are therefore removed in this reissuance.

Enclosures: Dominion's chlorine sampling report (10/6/09)
Cochran's Approximation to the Behrens-Fisher Student's t-Test
Completion of Project Notification (11/6/08).

Dominion Resources Services, Inc.
5000 Dominion Boulevard, Glen Allen, VA 23060
Web Address: www.dom.com

Dominion



CERTIFIED MAIL
RETURN RECEIPT REQUESTED

October 6, 2009

Ms. Emilee Carpenter
Water Permit Writer
Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, VA 23060

RE: **Chesterfield Power Station VPDES Permit No. VA0004146: Total Residual Chlorine Sampling of Screen Backwash Discharges**

Dear Ms. Carpenter:

Enclosed is a report describing the results of analyses for Total Residual Chlorine (TRC) performed using samples collected from the six intake screen backwash discharges (Outfalls 006 – 011) at Dominion's Chesterfield Power Station. This information is being provided to you in support of our July 6, 2009 permit application, which requested removal of the intake screen backwash outfalls from the station's VPDES permit.

Please feel free to contact Ken Roller of my staff at (804) 273-3494 should you have any questions concerning this information.

Sincerely,

Cathy C Taylor

Cathy C. Taylor
Director, Environmental Support

Enclosures

# Chesterfield Power Station
# Screen Backwash Discharge TRC Sampling

## BACKGROUND

During the fall of 2008, Dominion completed a project to relocate the points for chlorine injection into the station's circulating water system. The project was undertaken to comply with effluent limits for Total Residual Chlorine (TRC) that were placed on the station's intake screen backwash discharges (Outfalls 006 – 011) when the existing VPDES permit was reissued effective December 10, 2004. Through the compliance project, the chlorine injection points were relocated downstream of the points where water is withdrawn for use in the station's Intake Screen Backwash System. As a result, all intake screen backwash discharges now consist of James River water that has not been contaminated by use in any Chesterfield Power Station plant processes. Consequently, Dominion has requested that Outfalls 006 – 011 be removed from the permit during the upcoming permit reissuance. To support this request DEQ staff suggested that the result of at least one TRC analysis at each outfall be included in the permit renewal application, and that if possible the Quantification Level (QL) for the analyses should be no greater than 38 µg/L, which is the monthly average and maximum TRC permit limit. This document provides the TRC data generated by Dominion in support of DEQ's suggestion.

## METHODS and MATERIALS

TRC Analytical Procedure

TRC measurements were performed using a HACH DR 2800 Portable Spectrophotometer and the HACH Ultra Low Range (ULR) Method 10014 (see attached). The ULR method has a theoretical TRC range of 2 to 500 ug/L, and was selected for use in this project following conversations with contract laboratories, DEQ staff, and other permittees and consultants familiar with TRC analytical methods.

TRC Sampling and Analyses (June 24, 2009)

Grab samples were collected on June 24, 2009 from each of the six (6) screen backwash discharges and from two (2) locations within the James River upstream from the backwash outfalls. Locations of the backwash outfalls and two James River sampling stations are shown in Figure 1. All samples were collected during a period of chlorine addition to the station's circulating water system. The James River is the source of make-up water to the screen intake backwash discharges, and is tidal in the area of the Chesterfield Power Station. Consequently, to account for any background river TRC concentrations all samples were collected approximately midway through a period of ebb tide. The following TRC analyses were performed.

- A single TRC analysis was performed on the sample collected from the James River at sampling location A (just off the barge slip).
- Replicate TRC measurements were made on each of two samples collected from the James River sampling location B (near the Unit 6 intake) at 10:12 AM and 10:30 AM. An aliquot of the initial sample (collected at 10:12 AM) from this location was also tested for TRC following the addition of Potassium Iodide and Sodium Arsenite to correct for manganese interference. A portion of the second sample (collected at 10:30) from this location was retained for approximately three hours prior to TRC analysis.
- A single grab sample was collected from each of the screen backwash discharges. The following three TRC measurements were made on each sample:
    - An initial TRC concentration was determined
    - TRC was measured following addition of Potassium Iodide and Sodium Arsenite to correct for manganese interference
    - TRC was measured after allowing the sample to sit for approximately three hours.

TRC Sampling and Analyses (August 5, 2009)

Because of the variability observed in TRC concentrations determined for the samples collected on the June 24, 2009 (see results below), additional TRC analyses were performed on August 5, 2009 using samples of tap water and James River water. Samples of tap water were collected from the Chesterfield Power Station's laboratory spigot and were analyzed for TRC following the addition of increasing concentrations of dechlorination agent (blanking reagent). Tap water was also analyzed for TRC following the addition of blanking reagent and Potassium Iodide and Sodium Arsenite to correct for manganese interference.

Following testing of the tap water, four samples were collected from the James River sampling location A. The samples were collected approximately midway during a period of ebb tide, and were collected over a period of about one hour. The following TRC analyses were performed using HACH Method 10014:

- Sample 1 (9:37 AM) - An initial TRC measurement was followed immediately by a second TRC measurement. Aliquots of the sample were then treated with increasing concentrations of the method blanking reagent (0.5 – 1.5 ml) until a relatively stable TRC concentration was determined. An unaltered aliquot of the sample was then retested for TRC to examine persistence relative to the initial sample.
- Sample 2 (10:00 AM) - This sample was analyzed for TRC
- Sample 3 (10:10 AM) - An initial TRC concentration was determined. TRC measurements were then made on aliquots of the sample following addition of 1.5 ml of the method blanking reagent alone and following addition of the blanking agent plus Potassium Iodide and Sodium Arsenite to correct for manganese interference. An unaltered aliquot of the sample was then tested for TRC to examine persistence relative to the initial sample.

- Sample 4 (10:31 AM) – An initial TRC concentration was determined. TRC measurements were then made on aliquots of the sample following addition of 1.5 ml of the method blanking reagent alone and following addition of the blanking agent plus Potassium Iodide and Sodium Arsenite to correct for manganese interference.

## RESULTS & DISCUSSION

<u>TRC Sampling and Analyses (June 24, 2009)</u>

Results of the TRC analyses performed on samples collected June 24, 2009 are presented in Table 1, and are discussed below.

### James River TRC Concentrations

Chlorine concentrations measured in the James River samples varied considerably with initial TRC concentrations ranging from 27 ug/L at sampling Station A to 41 ug/L at Station B. Chlorine concentrations also varied considerably between the two samples collected from sampling location B, and between the three concentrations determined for the sample collected at 10:12 AM. Treatment of the 10:12 sample for manganese interference yielded a TRC concentration of 28 ug/L. This suggests that manganese may have been responsible for some of the TRC measured; however, relatively similar chlorine concentrations of 27 ug/L and 31 ug/L were determined for aliquots of the second sample collected from the same location at 10:30 AM. A chlorine concentration of 24 ug/L was determined for the 10:30 sample three hours.

### Screen Backwash TRC Concentrations

TRC concentrations measured in the screen backwash discharges ranged from 38 ug/L (Outfall 011) to 56 ug/L (Outfall 008). With the exception of Outfall 011 the initial TRC concentrations determined for all of the screen backwash discharges were slightly higher than TRC concentrations measured in the James River samples collected from Location B. Following treatment for manganese interference, TRC concentrations in the screen backwash discharges decreased in many outfalls (by 13 ug/L for Outfall 007) and ranged from 38 – 46 ug/L. In addition, chlorine concentrations were lower than initial readings three hours following sample collection in the samples from Outfalls 006, 007, 008, and 009.

The data generated for the James River samples indicate that chlorine was present in the river, and that TRC concentrations varied considerably between sampling locations in the James River as well as between samples collected from the same river location. It is not possible from the data, however, to determine whether the observed variability was due to spatial and/or temporal differences in TRC concentrations or resulted from one or more of the following factors: 1) differences in the concentrations of interfering substances, 2) the loss of chlorine from the sample over time, and/or 3) the normal variability associated with the analytical method. Similarly, elevated TRC concentrations were measured in the individual screen backwash discharges, but it is not possible to determine from the data the reason for this variability.

The mean concentration of chlorine for the two samples collected from the James River location B is 32.83 ug/L, and the average TRC concentration for the six screen backwash discharges is 46.17. A t-test shows no statistically significant difference between the two means at the 90% level (see attached test results).

TRC Sampling and Analyses (August 5, 2009)

Because of the variability in TRC concentrations observed following analysis of the James River and screen backwash samples, additional tests with tap water and James River water were undertaken on August 5, 2009 to gain a better understanding of the capabilities of the analytical method. Results of the August 5, 2009 testing are presented in Table 2 and are discussed below.

**Tap Water**

An initial chlorine concentration of 844 ug/L was determined for the CPS laboratory tap water, which is within the range of TRC concentrations expected for this water (see attached 2008 Colonial Heights Water Quality Report). Addition of 0.5 ml, 1.0 ml, 1.5 ml and 2.0 ml of the HACH Method 10016 blanking reagent (Dechlorinating Agent) reduced the measured TRC concentrations to 243 ug/L, 88 ug/L, 69 ug/L, and 57 ug/L, respectively. Addition of 1.5 ml of the blanking reagent plus sample adjustment for manganese interference resulted in a TRC reading of 66 ug/L. These results indicate that TRC can be reduced by the addition of the blanking reagent; however, the results also suggest that the analytical system may continue to produce positive TRC measurements as high as 57 ug/L even after the addition of 2.0 mg/L of the blanking reagent.

**James River Water (Sampling Location A)**

Sample 1 - A TRC concentration of 86 ug/L was determined for this sample. An immediate retest of the sample yielded a similar TRC concentration of 81 ug/L. Addition of 0.5, 1.0 and 1.5 ml of the HACH Method 10016 blanking solution resulted in TRC readings of 39 ug/L, 21 ug/L and 25 ug/L, respectively. Sample 1 was retested at 10:08 AM and a TRC concentration of 55 ug/L was measured.

Sample 2 - A TRC concentration of 61 ug/L was determined for this sample.

Sample 3 (10:10 AM) - An initial TRC concentration of 76 ug/L was measured in this sample. Addition of 1.5 ml of dechlorination reagent resulted in a TRC concentration of 19 ug/L. Measurement of the sample following addition of 1.5 ml of dechlorination agent and treatment for manganese interference resulted in a measurement of <1 ug/L TRC, indicating that approximately 19 ug/L of the previous TRC concentrations were due to the presence of manganese in the sample. A retest of the sample at 10:25 yielded a TRC concentration of 73 ug/L.

Sample 4 (10:31 AM) - An initial TRC concentration of 74 ug/L was measured in this sample. Addition of 1.5 ml of dechlorination reagent yielded a TRC concentration of 17 ug/L, and manganese correction plus 1.5 ml of dechlorination reagent resulted in a TRC concentration of 11 ug/L.

Results of the August 5, 2009 TRC sampling support the results obtained during the June 24, 2009 sampling. Chlorine concentrations at the James River sampling location A were extremely variable differing by 25 ug/l in the first two samples, which were collected 23 minutes apart. In addition, a retest of Sample 1, performed approximately 30 minutes following sample collection, yielded a TRC concentration that was 31 ug/L less than that measured in the initial reading of this sample.

In addition, treatment of Samples 1, 3 and 4 with the HACH dechlorinating agent substantially reduced the TRC concentrations measured in each of these samples indicating that TRC was present in the James River above the intakes for the Chesterfield Power Station circulating water system. Treatment with the dechloriniating agent, however, did not totally eliminate a positive TRC reading from any of the three samples. Additional treatment of Samples 3 and 4 for manganese interference totally (Sample 3) or partially (Sample 4) removed any residual positive TRC measurement from these samples.

## CONCLUSIONS

As suggested by DEQ, Dominion analyzed the Chesterfield Power Station's intake screen backwash outfalls for TRC using the HACH Ultra Low Range (ULR) Method 10014, which has a theoretical QL of at least 38 ug/L. In addition, Dominion also measured TRC concentrations in samples collected from the James River shortly before sampling of the intake backwash discharges, and performed additional tap water and James River sampling to further evaluate the performance of the analytical method. Based on these evaluations the following conclusions can be reached:

- Background TRC may be present in the James River upstream of the Chesterfield Power Station.
- TRC concentrations measured in the James River varied considerably between sampling locations in the James River as well between samples collected from the same river location on the same day and on different days. Considerable variability was also observed between the TRC concentrations determined for the individual screen backwash discharges. It is not possible from the data, however, to determine whether the observed variability was due to spatial and/or temporal differences in TRC concentrations or resulted from one or more of the following factors: 1) differences in the concentrations of interfering substances, 2) the loss of chlorine from the sample over time, and/or 3) the normal variability associated with the analytical method.
- The average concentration of TRC measured in the intake screen backwash discharges was not significantly different at the 90% confidence level from the average James River background TRC concentration.

Figure 1. Locations of Intake Screen Backwash Outfalls and James River TRC Sampling Stations

**Table 1. Total Residual Chlorine (TRC) Measured in Samples from the Intake Screen Backwash Discharges and the James River (06/24/2009)**

| SAMPLE LOCATION | DR2800 | | Sample 1 | | Sample 2 | | Mn Interference | *Persistence Test |
|---|---|---|---|---|---|---|---|---|
| River Sampling Location A | Sample Time | 9:50 | [redacted] | | | | | |
| | Chlorine Reading | 27 | | | | | | |
| River Sampling Locatoin B | Sample Time | 10:12 | 10:12 | 10:12 | 10:30 | 10:30 | 10:12 | Collected 10:30 / Ran 13:30 |
| | Chlorine Reading | 41 | 31 | 38 | 27 | 31 | 28 | 24 |
| Outfall 011 (U6) | Sample Time | 10:41 | [redacted] | | | | 10:41 | Collected 10:41 / Ran 13:35 |
| | Chlorine Reading | 38 | | | | | 38 | 38 |
| Outfall 010 (U5) | Sample Time | 11:30 | | | | | 11:30 | Collected 11:30 / Ran 13:49 |
| | Chlorine Reading | 42 | | | | | 40 | 42 |
| Outfall 009 (U4) | Sample Time | 11:43 | | | | | 11:43 | Collected 11:43 / Ran 13:50 |
| | Chlorine Reading | 49 | | | | | 46 | 42 |
| Outfall 008 (U3) | Sample Time | 11:53 | | | | | 11:53 | Collected 11:53 / Ran 13:55 |
| | Chlorine Reading | 45 | | | | | 41 | 38 |
| Outfall 007 (U8) | Sample Time | 11:18 | | | | | 11:18 | Collected 11:18 / Ran 13:45 |
| | Chlorine Reading | 56 | | | | | 43 | 29 |
| Outfall 006 (U7) | Sample Time | 11:05 | | | | | 11:05 | Collected 11:05 / Ran 13:40 |
| | Chlorine Reading | 47 | | | | | 39 | 29 |

*Persistence Test: samples were poured into open bottles in the field and TRC analyses performed several hours later in the lab to test if the chlorine had dissipatec

Chesterfield's chlorine system was in service during sampling

James River tide was going out, at lowest at 13:20

Reagent blank = 2 ug/l (TRC data in the table account for this analytical background concentration).

All concentrations (ug/L)

Table 2. Total Residual Chlorine (TRC) measured in samples of Tap Water and James River Water (08/05/2009)

| Time | Sample | 1 ml buffer + 1 ml TRC indicator | Dechlorinating Agent (ml) | Manganese Adjustment | TRC (ug/L) |
|---|---|---|---|---|---|
| | | Tap Water | | | |
| 8:00 | Method Blank (DI) | Yes | 0.5 | No | 2 |
| | Initial Reading | Yes | 0 | No | 844 |
| | Dechlorination | Yes | 0.5 | No | 243 |
| | Dechlorination | Yes | 1 | No | 88 |
| | Dechlorination | Yes | 1.5 | No | 69 |
| | Dechlor. + Mn | Yes | 1.5 | Yes | 66 |
| | Dechlorination | Yes | 2 | No | 57 |
| 9:15 | Dechlor. Agent Adsorbance Check | No | 1.5 | No | -1 |
| | | James River Sample 1 | | | |
| 9:37 | Initial Reading | Yes | 0 | No | 86 |
| | Retest | Yes | 0 | No | 81 |
| | Dechlorination | Yes | 0.5 | No | 39 |
| 9:58 | Dechlorination | Yes | 1 | No | 21 |
| | Dechlorination | Yes | 1.5 | No | 25 |
| 10:08 | Retest Sample | Yes | 0 | No | 55 |
| | | James River Sample 2 | | | |
| 10:00 | Only Test with Sample | Yes | 0 | No | 61 |
| | | James River Sample 3 | | | |
| 10:10 | Initial Reading | Yes | 0 | No | 76 |
| | Dechlorination | Yes | 1.5 | No | 19 |
| | Dechlor. + Mn | Yes | 1.5 | Yes | -1 |
| 10:25 | Restest Sample | Yes | 0 | No | 73 |
| | | James River Sample 4 | | | |
| 10:31 | Initial Reading | Yes | 0 | No | 74 |
| | Dechlorination | Yes | 1.5 | No | 17 |
| | Dechlor. + Mn | Yes | 1.5 | Yes | 11 |

*Statistical comparison of the mean TRC concentrations determined for the James River (group 1) and the intake screen backwash discharges (group 2).*

***The SAS System***

***The TTEST Procedure***

| Statistics | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable** | **group** | **N** | **Lower CL Mean** | **Mean** | **Upper CL Mean** | **Lower CL Std Dev** | **Std Dev** | **Upper CL Std Dev** | **Std Err** | **Minimum** | **Maximum** |
| **value** | **1** | 2 | -16.07 | 32.85 | 81.769 | 2.4292 | 5.4447 | 173.74 | 3.85 | 29 | 36.7 |
| **value** | **2** | 6 | 39.683 | 46.167 | 52.65 | 3.8563 | 6.1779 | 15.152 | 2.5221 | 38 | 56 |
| **value** | **Diff (1-2)** | | -25.43 | -13.32 | -1.206 | 3.9062 | 6.0619 | 13.349 | 4.9495 | | |

| T-Tests | | | | | |
|---|---|---|---|---|---|
| **Variable** | **Method** | **Variances** | **DF** | **t Value** | **Pr > \|t\|** |
| **value** | **Pooled** | Equal | 6 | -2.69 | 0.0360 |
| **value** | **Satterthwaite** | Unequal | 1.97 | -2.89 | 0.1034 |

| Equality of Variances | | | | | |
|---|---|---|---|---|---|
| **Variable** | **Method** | **Num DF** | **Den DF** | **F Value** | **Pr > F** |
| **value** | **Folded F** | 5 | 1 | 1.29 | 1.0000 |

Cochran's Approximation to the Behrens-Fisher Student's t-Test (at a 5% Level of Significance)
To use this spreadsheet, please fill in only the shaded boxes.

-----------------------------------------------------------------

| | |
|---|---|
| Permit Number | VA0004146 |
| Facility Name | Chesterfield Power Station |
| Parameter | Total Residual Chlorine |
| What is the number of observations in the set of background data ($n_b$)? | 2 |
| What is the number of observations in the set of monitoring data ($n_m$)? | 6 |

| | Background | Monitored Site | $[X_b-X_b(ave)]^2$ | $[X_m-X_m(ave)]^2$ |
|---|---|---|---|---|
| 1 | 27 | 38 | 49.000 | 66.694 |
| 2 | 41 | 42 | 49.000 | 17.361 |
| 3 | | 49 | 0.000 | 8.028 |
| 4 | | 45 | 0.000 | 1.361 |
| 5 | | 56 | 0.000 | 96.694 |
| 6 | | 47 | 0.000 | 0.694 |
| 7 | | | 0.000 | 0.000 |
| 8 | | | 0.000 | 0.000 |
| 9 | | | 0.000 | 0.000 |
| 10 | | | 0.000 | 0.000 |
| 11 | | | 0.000 | 0.000 |
| 12 | | | 0.000 | 0.000 |
| 13 | | | 0.000 | 0.000 |
| 14 | | | 0.000 | 0.000 |
| 15 | | | 0.000 | 0.000 |
| 16 | | | 0.000 | 0.000 |
| 17 | | | 0.000 | 0.000 |
| 18 | | | 0.000 | 0.000 |
| 19 | | | 0.000 | 0.000 |
| 20 | | | 0.000 | 0.000 |

$X_b(ave) =$ 34.000 $X_m(ave) =$ 46.167

$T_b =$ 6.314 (from lookup table)
$T_m =$ 2.015

$s_b^2 =$ 98.000 $= [(X_{b1}-X_b(ave))^2+(X_{b2}-X_b(ave))^2...(X_{bn}-X_b(ave))^2]/(n_b-1)$
$s_m^2 =$ 38.167 $= [(X_{m1}-X_m(ave))^2+(X_{m2}-X_m(ave))^2..(X_{mn}-X_m(ave))^2]/(n_m-1)$

**$T_{star}$ = 1.635** $= [X_m(ave)-X_b(ave)]/sqrt(s_m^2/n_m + s_b^2/n_b)$

$W_b =$ 49.000 $= s_b^2/n_b$
$W_m =$ 6.361 $= s_m^2/n_m$

**$T_{comp}$ = 5.820035625** $= (W_b*T_b + W_m*T_m)/(W_b + W_m)$

## There is no significant difference between the monitoring data and the background data

Dominion Generation
Chesterfield Power Station
500 Coxendale Road, Chester, VA 23836

Dominion®

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NOV 10 2008
PRO

November 07, 2008

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Virginia Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, Va. 23060

**Re: CHESTERFIELD POWER STATION - VPDES DISCHARGE MONITORING REPORT FOR OCTOBER, 2008**

Gentlemen:

Attached are the original and one copy of the October, 2008 VPDES Discharge Monitoring Reports for Chesterfield Power Station. Also attached are ground water remediation results for October, 2008, the Nutrient DMR's, and the final TRC Effluent Limit Compliance Project Progress Report.

As you know, this report is required by and prepared specifically for the Virginia Department of Environmental Quality. It represents truly, accurately, and completely the observed results of the measurements and analyses required by the state to be performed or submitted, but only such results. It is not intended as an assertion of the accuracy on any instrument, readings, or analytical result, nor is it an endorsement of the suitability of any analytical or measurement procedure.

If you have any questions or desire additional information, please do not hesitate to contact us.

Sincerely,

Richard T. Elder
Station Director

Attachments

cc: CPS Laboratory

# Chesterfield Power Station
# Total Residual Chlorine Effluent Limit Compliance Project
# Final Progress Report
# (November 6, 2008)

The VPDES permit for the Chesterfield Power Station (Permit No. VA0004146) was reissued on December 10, 2004 and contains Monthly Average and Daily Maximum Total Residual Chlorine (TRC) limits of 38 ug/L on the screen backwash discharges (Outfalls 006 – 011). The station is to achieve compliance with the Total Residual Chlorine limitations no later than 48 months following the effective date of the permit (December 10, 2008).

By letter dated June 8, 2006, Dominion submitted to DEQ our Plan of Action and Conceptual Engineering Report for achieving compliance with the TRC limits. The method selected to achieve compliance is to relocate the points for sodium hypochlorite injection, which will provide an unchlorinated freshwater supply to each of the screen wash systems. The compliance plan was approved by DEQ on June 23, 2006 and Dominion began implementation of the plan in August 2006. Our progress on this project to date is described below:

## Project Progress

- All installation activities have been completed.
- Commissioning has been completed.
- The project has been completed. Chlorine has been removed as a potentially discharged pollutant and, as our DMR indicates, we are in compliance with the Total Residual Chlorine limitations.

Please contact Dawn Garber at (804) 796-6350 should you have any questions concerning this project.

**Attachment 7**

Discussion of 316(a) and 316(b)

2012 Discussion:
According to Dominion's reissuance applicaton, station operations have not materially changed since the approval of the 316(a) variance in 2004. There is also no evidence that the stream characteristics have materially changed since that time. Consequently, it appears that the 316(a) study approved in 2004 remains representative for the James River and station operations. The variance, therefore, is carried forward in this reissuance.

# Clean Water Act Sections 316(a) and 316(b)

## Request to Continue CWA Section 316(a) Variance

Chesterfield Power Station currently operates under a Clean Water Act (CWA) Section 316(a) thermal variance, which was granted by DEQ with reissuance of the VPDES Permit. The process leading to DEQ's decision to grant the 316(a) variance spanned about seven years. During this seven-year period, Dominion worked closely with the DEQ and other stakeholders to develop and implement a comprehensive 316(a) demonstration study plan. The study plan approved by DEQ, and carried out by Dominion, was multifaceted and consisted of resource intensive field investigations involving the collection of extensive environmental data. These data were coupled with state-of-the-art hydrodynamic modeling to examine the thermal impacts to the James River associated with operation of the power station at full station thermal load conditions. Results of the 316(a) study were reviewed by fisheries biologists who are considered expert in their field. Their review found, and DEQ concurred, that the thermal discharge from the Chesterfield Power Station does not cause appreciable harm to the overall aquatic biological community and that a balanced, indigenous community of shellfish, fish, and wildlife does exist in the James River in the vicinity of the power station.

The current VPDES permit for the Chesterfield Power Station contains heat rejection limits (expressed as BTUs/hr) on the three non-contact cooling water discharges (Outfalls 001, 002, and 003). Through the above 316(a) studies Dominion successfully demonstrated that the existing heat rejection limits are protective of the balanced, indigenous aquatic community in the James River. Since completion of these studies and issuance of the variance, station operations have not materially changed with respect to the cooling water discharges and there are no current plans to increase the thermal loading from the Chesterfield Power Station beyond the existing thermal limitations. Dominion believes that the data generated during our 316(a) studies remains representative for the James River and for our station operations, and therefore, we request continuance of Chesterfield's 316(a) variance.

## Clean Water Act Section 316(b)

The Chesterfield Power Station withdraws water from the James River for use in plant processes. The majority of the water withdrawn is used in a once-through cooling water system to dissipate waste heat from the station's generating units. The intake structures associated with this withdrawal are regulated under Clean Water Act Section 316(b). The following is a brief summary of 316(b) related activities that Dominion has been involved with, relative to the Chesterfield Power Station, during the effective term of the existing VPDES permit.

On July 9, 2004, EPA promulgated new 316(b) regulations governing cooling water intake structures for existing power plants (Phase II rule), such as the Chesterfield Power Station. Under the Phase II rule, Dominion was required to prepare and submit a Comprehensive Demonstration Study (CDS) for the Chesterfield Power Station providing Dominion's mechanism for documenting compliance with the Phase II regulatory requirements. A special condition was included in Chesterfield's VPDES permit requiring submittal of the CDS by January 7, 2008 as part of an application for permit renewal to incorporate 316(b) compliance alternatives.

As an initial step in the CDS process, Dominion prepared a Proposal for Information Collection (PIC) that described our approach to achieving compliance with the rule and the processes that would be used to generate the information required for CDS development. The PIC for the Chesterfield Power Station was submitted to DEQ on February 16, 2005 and was subsequently approved by DEQ by letter dated July 29 2005. Another step in the CDS development process involved studies to investigate the degree that the existing aquatic population of the James River is being impinged and/or entrained by Chesterfield Power Station's current water withdrawal system. Dominion carried out these studies between July 2005 and June 2006.

On July 9, 2007 EPA suspended the requirements of the Phase II rule. As a result of this action, the DEQ modified Chesterfield's VPDES Permit on January 1, 2007 to remove the requirement for submittal of the 316(b) related permit application. This condition was replaced with the current Special Condition I.B.21 which requires submittal of the biological data generated as part of the approved PIC by December 31, 2008. In compliance with this requirement, Dominion submitted a report containing the impingement mortality and entrainment characterization results to DEQ on December 29, 2008.

# 2004 Discussion

## Attachment 7 – 316(a) Demonstration

Special Condition 6 in the existing VPDES permit addresses the operation of a sparger system in the Outfall 003 discharge canal to remove heat from the 003 wastestream. Heat removal attributable to the full system (32 pump platforms with 4 nozzles each) was theoretically $684.3 \times 10^6$ BTU/Hour. (Addition of that value to the thermal limitation in the existing permit of $4.87 \times 10^9$ BTU/Hour results in the proposed limitation of $5.55 \times 10^9$ BTU/Hour.)

In 1995, Virginia Power began discussions with DEQ staff regarding the retirement of the sparger system. As retirement of the system represented a theoretical increase in the thermal discharge at Outfall 003, the staff responded that a 316(a) study provided the best mechanism for evaluating the issues associated with an increased thermal loading. Section 316(a) of the Clean Water Act allows for a demonstration that thermal limitations do not have to be more stringent than what is necessary to assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is made. Included in this attachment are letters dated December 21, 1995 from Virginia Power, June 27, 1996 from Virginia Power, September 27, 1996 from DEQ, and January 15, 1997 from Virginia Power. These letters provide a brief summary of the development of the 316(a) study plan. Except for Dr. John Ney's report submitted with Virginia Power's June 27, 1996 letter and the study plan submitted with the January 15, 1997 letter, attachments mentioned in the letters are not included in this fact sheet.

The goal of the study was to demonstrate that the requested increase in thermal loading from Outfall 003 would be in accordance with the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is made. The study consisted of two parts: Collection of data to document the current condition and a thermal modeling effort to predict the increase in stream temperatures at the higher thermal loading. Virginia Power was allowed to turn off the sparger system so that the thermal loading at Outfall 003 would be as close as possible to the requested loading during the 316(a) study. An initial, cursory modeling effort gave some indication of what could be expected when the spargers were turned off and provided the basis for staff approval to turn them off.

The following items are included in this attachment to provide a summary of the results of the 316(a) study:

1. The "Executive Summary" and "Conclusions" from Virginia Power's 316(a) Demonstration Report.

   Also included from the 316(a) report are sections discussing fish kills that have occurred in Farrar Gut – pages 7-29 through 7-31 and 7-41 through 7-45. Also see Dr. John Ney's report dated June 1996.

2. Letter dated July 20, 2001 from DEQ staff concurring with the conclusions of the 316(a) study report. The need for additional thermal modeling was also noted.

3. The "Executive Summary" and "Conclusion" from HydroQual's thermal modeling report dated November 7, 2003.

4. Papers from Dr. John Ney and Dr. Cynthia Jones commenting on the impact of the predicted rise in temperatures at the proposed thermal loading on the conclusions reached in the 316(a) study report.

The existing permit defines the thermal mixing zone ($\Delta T > 3^{o}$ C) as follows: The old channel of the James River around Farrar Island to its confluence with the main channel of the James River at Dutch Gap, the coves and inlets of Farrar Island, and the main channel of the James River, its bays, coves, inlets, and meanderings form the upstream boundary at navigational aid QK F1 "155" (37° 23' 1" N and 77° 23' 1" W) to the downstream boundary at navigational aid F1 sec "147" (37° 22' 7" N and 77° 19' 4" W). The projected mixing zone based on the HydroQual modeling at the proposed thermal loading does not appear to reach as far downstream as the existing, defined zone, and certainly does not extend the existing zone.

The 316(a) study and related thermal modeling focus on shellfish, fish, and wildlife as discussed above. Over the past several years in particular, questions have also been raised about the human health effects of the elevated temperatures in Farrar Gut; i.e, effects associated with swimming, boating, etc. (See the table in Attachment 5.c. for Outfall 003 temperature data.) The staff has discussed these issues with the State Department of Health, Virginia Power, and Central Office staff. At this time our water quality standards do not support the imposition of an effluent limitation in the permit based on human health concerns. Virginia Power has historically demonstrated compliance with the designated thermal mixing zone, and a successful 316(a) demonstration represents compliance with the State's temperature standards. The issue of human health effects must be more specifically addressed in our standards before we can consider recommending a permit condition, which could also have implications for other heated discharges. The Health Department is working with Virginia Power to insure that appropriate signage is in place to inform the public of possible risks.

Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, Virginia 23060

DEC 1995
PRO

VIRGINIA POWER

cc: EPA

December 21, 1995

Mr. Ray R. Jenkins
Environmental Engineer Senior
Piedmont Regional Office
Department of Environmental Quality
P. O. Box 6030
Glen Allen, Virginia 23058

**RE: CHESTERFIELD POWER STATION-VPDES PERMIT NO. VA0004146-REQUEST TO AMEND HEAT REJECTION RATE REQUIREMENTS FOR OUTFALL 003**

Dear Mr. Jenkins:

This letter requests deletion of Special Condition No. 3 from VPDES Permit No. VA0004146 and recalculation of the allowable heat rejection rate for Outfall 003. This request is made as part of the permit renewal process. We will file our complete application for renewal of the permit early next year but we request that review and consideration of our request to delete the Special Condition and recalculate the Outfall 003 heat rejection rate begin as soon as possible.

Outfall 003 is the discharge of condenser cooling water from Units 4, 5, and 6 at Chesterfield Power Station into Farrar Gut, an oxbow segment of the James River. Special Condition No. 3 involves the operation of the spray module or sparger system in the Outfall 003 discharge canal and the accounting of the heat rejection rate attributable to the operation of the sparger system. The system was installed in 1971 at a cost of $1.5 million and a design maximum energy consumption of 2.5 megawatts of electricity. Current annual operating and maintenance costs are approximately $0.5 million.

Virginia Power believes that the sparger system is not justified or cost effective from an environmental and regulatory perspective and that the system should be removed from service. Concomitant with removal of the system, the heat rejection rate requirements for Outfall 003 should be recalculated to reflect the design conditions of the electric generating units and the condenser cooling water discharge.

We are not proposing any change to the thermal mixing zone requirements in the renewed permit. Compliance with the state water quality thermal standards at the end of the mixing zone will not be compromised by removal of the sparger system. Importantly, in our best professional judgement, we do not expect any adverse ecological impact associated with removing the system.

We have reviewed the legal and regulatory basis for removing the system and increasing the allowable heat rejection rate. Our conclusion is that the antibacksliding policy of the state does not apply. Moreover, we believe that if the policy did apply, our requested action is not prohibited by the policy. We have attached a legal analysis addressing these issues that was prepared by our counsel.

Your timely review of this attachment and our request would be appreciated. Once you have reviewed the legal analysis, we would like to meet with you to answer any questions that may arise and to further discuss the regulatory and environmental issues. I have asked Bob Williams to contact you during the week of January 1, 1996 to set up a meeting. Meanwhile, if you have any immediate questions regarding this letter or attachment, please contact him at 273-2994.

Sincerely,

A. W. Hadder

A. W. Hadder
Manager
Environmental Policy and Compliance

Attachment

RJW/jmh

Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, Virginia 23060

June 27, 1996

JUN 1996
PRO

VIRGINIA POWER

cc: EPA

Mr. Ray R. Jenkins, Jr.
Environmental Engineer Senior
DEQ-Piedmont Regional Office
4949-A Cox Road
Glen Allen, Va 23060-6296

Dear Mr. Jenkins:

As you are aware, since December of 1995, Virginia Power has been discussing with the Department of Environmental Quality (DEQ) a request to retire the spray module or sparger system in the cooling water discharge canal, Outfall 003, at Chesterfield Power Station (see letter from A. W. Hadder dated December 21, 1995). DEQ has expressed some concern over existing conditions in Farrar Gut including reported fish kills. After several meetings and phone conversations, Virginia Power agreed to address the issues and concerns identified by DEQ. A draft study plan was submitted to DEQ and comments were received and responded to on April 23, and May 6, 1996, respectively.

Three primary task items were identified in the study plan. Each task item and the consultant hired to perform the requested work are listed below:

1) Legal analysis of state and federal antibacksliding requirements-performed by James Christman, Esq. of Hunton & Williams.

2) Modeling study to predict thermal mixing zone compliance and water temperature conditions, without sparger operation-performed by CH2M Hill (The modeling protocol was approved June 10,1996 by Dale Phillips of DEQ).

3) Ecological assessment of reported fish kills in Farrar Gut-performed by Dr. John Ney of Virginia Polytechnic Institute and State University.

Enclosed are the final reports of each of the three areas of interest. Five additional copies are also included for distribution within the Piedmont and Central DEQ offices.

Overall, the reports provide several conclusions related to the regulatory and environmental issues associated with retiring the spargers:

1) The legal analysis concluded that increasing the heat rejection limit does not violate state or federal antibacksliding rules.

2) The model predicted that without sparger operation the temperature at the mouth of Farrar Gut would increase only 0.4° C and 0.5°C in the winter and summer, respectively, with a linear maximum increase of 1°C to 2°C at the upper end of the Gut. Upon retirement of the spargers, the thermal discharges at Chesterfield Power Station are expected to continue to comply with the Virginia Water Quality Standards Regulation (VR680-21-00).

3) The ecological assessment concluded that most of the reported fish kills were dominated primarily by one species, gizzard shad, and were probably caused by some rapid but transient change in water quality. The cause of the most recent kill, during the winter of 1996, is attributed to an unusually severe winter which reduced ambient water temperatures. Winter cold shock kills will continue to be a function of extreme climatological conditions, which will far override the effect of a small rise in discharge temperature. The loss of gizzard shad in Farrar Gut is considered economically slight and ecologically insignificant to the balance indigenous community in the James River. (Please note that a copy of Dr. Ney's report has also been forwarded to the Virginia Department of Game and Inland Fisheries.)

Virginia Power believes that the attached reports properly address the concerns of DEQ and that the findings strongly support our original request to retire the spargers. Accordingly, we ask that Special Condition No. 3 be removed from VPDES No. VA 0004146 and that the heat rejection limit for Outfall 003 be increased to <u>5.83X$10^9$Btu/hour</u> (existing limit plus credit allowed, with an additional 5% to allow for improvements in station efficiency). We also request that the new heat rejection limitation be incorporated into the new permit, expected to be issued this fall.

If our request for permit modification is granted, Virginia Power proposes to leave the spargers in the discharge canal for one year as a precautionary measure. In the event compliance or environmental concerns arise during this period, the system could be placed back in operation. In addition, we will be contacting you soon to schedule a meeting to review our request and to discuss any interests in future monitoring.

Please let me know if you have any questions (273-2948).

Sincerely,

Judson W. White

J. W. White
Director
Environmental Compliance-Water/Waste

Attachments

JWW/jmh

cc:
Jim Christman - H&W
Lisa Sullivan - CH2M Hill
Dr. John Ney - VPI
Gary Martel - VDGIF(w/Dr. Ney's report)

COMMONWEALTH of VIRGINIA
*DEPARTMENT OF ENVIRONMENTAL QUALITY*
PIEDMONT REGIONAL OFFICE
4949-A Cox Road
Glen Allen, Virginia 23060
(804) 527-5020
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http://www.deq.state.va.us

George Allen
Governor

Becky Norton Dunlop
Secretary of Natural Resources

Thomas L. Hopkins
Director

Gerard Seeley, Jr.
Piedmont Regional Director

cc: EPA

September 27, 1996

Mr. J. W. White
Director
Environmental Compliance -- Water/Waste
Virginia Power
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, Virginia 23060

RE: VPDES Permit VA0004146 -- Chesterfield Power Station

Dear Mr. White:

As discussed at our meeting on September 11, 1996 the staff of the Department of Environmental Quality has reviewed the requirements of a 316(a) study and attempted to identify those areas that are of greatest concern for the James River/Farrar Gut area. Our reference for the following discussion is a draft document developed by the EPA titled "Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Sections of Nuclear Facilities Environmental Impact Statements" dated May 1, 1977. A copy of that document is enclosed.

The EPA document identifies categories of study and establishes for six biotic categories criteria for determining if a thermal discharge represents a "low potential impact" to that category. If classified as "low potential impact", the amount of additional work needed to address that category should be minimal and a Type III Low Potential Impact Determination will be needed (see page 63 of document).

Our evaluation of the requirements of a 316(a) demonstration is as follows:

1. Phytoplankton

   This biotic category may possibly be classified as "low potential impact". There are important questions about the phytoplankton community however, that should be answered by an "Other Type III Demonstration" (see page 64 of document). The demonstration

Phytoplankton (continued)

should include algal identification and chlorophyll analyses at stations in Farrar Gut, the "Lone Star" quarry, the Jones Neck and Presquile Isle oxbows, the quarry located just below Jones Neck Cutoff (public access available), and upstream above any thermal influence (above Buoy 157).

2. Zooplankton and Meroplankton

   This biotic category can probably be classified as "low potential impact". A Type III Low Potential Impact Determination will be needed.

3. Habitat Formers

   This biotic category can probably be classified as "low potential impact". A Type III Low Potential Impact Determination will be needed.

4. Shellfish/Macroinvertebrates

   This biotic category may possibly be classified as "low potential impact". There are important questions about the shellfish/macroinvertebrate community however, that should be answered by an "Other Type III Demonstration". The demonstration should include a comparison of the benthic community in Farrar Gut to that in the Presquile Isle oxbow.

5. Fish

   A Type II Demonstration (see page 34 of document) is required for this category. An endangered species that may be in the study area is the sturgeon.

6. Other Vertebrate Wildlife

   This biotic category can probably be classified as "low potential impact". A Type III Low Potential Impact Determination will be needed.

7. The outline for conducting a Type II study identifies a number of areas that must be addressed. Of particular importance are the following sections:

   a. Plant Operating Data (3.5.3.1.), especially the section that requires an assessment of chlorine in the discharge.

   b. Hydrologic Information (3.5.3.2.), especially the determination of tidal range; i.e., the upstream and downstream tidal excursion.

   c. Plume Data Requirements (3.5.3.5.) with isotherms plotted at 1°C intervals.

As the VPDES permit for the Chesterfield Power Station has expired, your comments on the feasibility of conducting a 316(a) demonstration would be appreciated as soon as possible and by no later than October 15, 1996.

We are continuing to research other questions you have raised and will respond as soon as possible.

Please contact me at 804/527-5037 if you have any questions. If you feel that a meeting would be helpful please let me know.

Sincerely,

Ray R. Jenkins, Jr.

Ray R. Jenkins, Jr.
Environmental Engineer Senior
Water Permits

/rrj

cc: DEQ – Water Environmental Research and Standards
DEQ – Office of Water Permit Support

Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, Virginia 23060



VIRGINIA POWER

January 15, 1997

PRO - Paylor, Bell, alling, Daub, Pfeifle

WER&S - Daub

EPA

OWPS

Ray R. Jenkins
Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, VA 23060-6295

**RE: 316(a) Study Plan**

Dear Mr. Jenkins:

Attached is Virginia Power's proposed study plan to conduct a 316(a) demonstration for Chesterfield Power Station to determine if current thermal limitations and requirements are more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in the James River/Farrar Gut area. We appreciate your suggestions for study categories in your September 27, 1996 letter to me and we believe we have sufficiently addressed all of the categories in our study plan.

Please note that we have hired the following two consultants to assist us during the study:

1) Dr. John Ney - Professor and Fisheries Section Coordinator, Virginia Polytechnic Institute and State University

2) Dr. Cynthia Jones - Associate Director, Applied Marine Research Laboratory, Old Dominion University

The consultants made recommendations concerning the development of the study plan and will be advising us during the study. In addition, John Kauffman of the Virginia Department of Game and Inland Fisheries, has agreed to participate in the study and provide input into the process as appropriate.

The study plan includes a temperature monitoring program that willl fulfill the requirements of Special Conditions 5 of the draft VPDES permit. Quarterly reports will be submitted according to the schedule in the draft permit. A revised monitoring protocol will be submitted within 60 days after the end of data collection for the 316(a) study.

Initiation of field data collection will commence upon DEQ approval of the study plan. We wish to start the study during the first quarter of 1997.

Thank you for your timely review of the proposed study plan. Please call me at 273-2948 if you have any questions.

Sincerely,

John W. White

J. W. White
Director
Environmental Compliance-Water/Waste

Attachment

**STUDY PLAN FOR A 316(a) DEMONSTRATION AT**

**CHESTERFIELD POWER STATION**

**JANUARY 1997**

## INTRODUCTION

In accordance with Section 316(a) of the Clean Water Act, Virginia Power has decided to undertake a study to demonstrate whether the current thermal limitations in VPDES Permit VA0004146 for Chesterfield Power Station (CPS) are more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in the upper tidal James River adjacent to the power station. A detailed study plan is described in this document and includes all appropriate environmental components, including items recommended by the Department of Environmental Quality (DEQ) in a letter dated September 27, 1996 from R.R. Jenkins, necessary to determine what thermal limitations and requirements are adequate to permit efficient operation of the power station while assuring the protection of the aquatic community.

EPA has not issued final guidance that establishes the required elements of a 316(a) demonstration; however, several draft documents have been published ( DEQ references a 1977 draft EPA document in the above mentioned letter). The draft documents describe various demonstration types (e.g., 1,2, or 3) and also provide for alternative study plans based upon the uniqueness of the receiving water and the approval by the authorized state agency. It is not Virginia

Power's intent to propose a specific demonstration "Type", but to submit a study plan for DEQ approval that will allow for the determination of whether the thermal discharges from CPS cause appreciable harm to the biological communities to the extent of interfering with the protection and propagation of a balanced, indigenous community of shellfish, fish, and wildlife.

The study will essentially examine the thermal impacts associated with the operation of the entire power station ( Units 3-8 )on the James River/ Farrar Gut area. Virginia Power is specifically interested in determining if the demonstration can justify the retirement of a floating power spray module system, called a sparger system, used to reduce heat discharged from Units 4, 5, and 6. This system was voluntarily installed in the early 1970s to provide supplemental cooling as well as to increase dissolved oxygen levels in the river. Virginia Power believes that the continued operation of the sparger system is not cost effective because there are no perceived environmental benefits associated with its current operation.

A single variable is difficult to isolate in a complex ecological system such as the upper tidal James River; therefore, impact assessment should be related to the total effect on the ecosystem. This holistic approach allows scientists to consider the resiliency of biological systems to imposed perturbations in assessing community health. For example, it may be possible that biological changes or localized impacts within the Farrar Gut area could be identified while still maintaining a balanced, indigenous community . Therefore, it is important to sample the biota seasonally and in areas within and outside the influence of the thermal discharge. In addition, information on station operation, local hydrology, and thermal isotherms is necessary to relate to the results of biological sampling..

## METHODS

### Study Sites and Frequency

Sampling locations will be selected to make physical and biotic comparisons among similar habitats that are in Farrar Gut, the mainstem of the river, and areas out of the influence of the thermal effects (e.g., James Island and Turkey Island oxbows). Seasonal collections will be made to reflect anticipated differences in the physical, chemical, and biological environment.

### Water Temperature and Dissolved Oxygen

Temperature and dissolved oxygen levels are interrelated and are important physicochemical parameters in any thermal study of an aquatic ecosystem. Water temperature and dissolved oxygen surveys will be conducted six times per year (Table 1) at Stations JR1, JR2, JR3, JR4, JR5, JR6, JR7, JR8, JN1 and TI1 in the James River, at Stations FG1, FG2, FG3, and FG4 in Farrar Gut, and at Stations Q1 and Q2 to represent quarries adjacent to both the gut and river (Figure 1). Water temperature will be measured to the nearest 0.1°C and dissolved oxygen to the nearest 0.1 mg/l using Hydrolab Surveyor 3 water quality meters. Measurements will be made in one meter increments surface to bottom at mid-channel and near both shores for a total of three sampling locations on a transect at each station with the exception of the two quarry stations, and at Station FG2, where channel width is minimal. At these stations, surface to bottom profiles will be made near the center of the quarries and at mid-channel at FG2. Transect surveys will commence at slack before ebb tide and/or slack before flood tide. The surveys performed during low water slack (LWS) tides will start at the downstream stations and work upstream. The surveys conducted at high water slack (HWS) will begin upstream and work downstream. If an initial survey is performed on LWS, then one week later a complementary survey will be performed at HWS. If the initial survey is performed on HWS, then one week later a complementary survey will be performed on LWS.

In addition, continuous temperature recorders will be installed on the first survey of each pair of surveys at Stations JR1, JR5, JN1, and TI1 in the James River and at Stations FG1, FG3, and FG4 in Farrar Gut.. The instruments will be programmed to record temperatures at one hour intervals, and will subsequently be retrieved on the second survey of each paired survey, one week later per quarter.

Nutrients

Nutrient input from both point sources and non-point sources can affect the relative abundance and species composition of both phytoplankton and zooplankton populations in the James River and Farrar Gut. Water samples will be collected quarterly (Table 1) and analyzed for total phosphorus, nitrate + nitrite, and ammonia at Stations JR1, JR5, JR7, JN1 and TI1 in the James River and at Stations FG2, FG3 and FG4 in Farrar Gut (Figure 1) using a 3 meter PVC pipe with a diameter of 4 cm. This collection method allows for an integrated surface and subsurface water grab. Tidal conditions will be documented for each survey. Total phosphorus will be measured using EPA Method 365.2, nitrate + nitrite will be measured using EPA Method 353.2, and ammonia will be measured using EPA Method 350.3.

Phytoplankton and Chlorophyll (a)

Phytoplankton generally represent a significant portion of the basic energy requirements in most surface waters through their ability to convert solar energy and inorganic carbon to usable food materials for zooplankton and some fish species (Odum 1971; U.S. EPA 1977). While most rivers and streams are considered "low potential impact areas" for phytoplankton according to U.S. EPA's 316(a) Technical Guidance Manual (1977), there are concerns of thermal discharges resulting in phytoplankton population shifts toward nuisance species. Water samples for both qualitative and quantitative analyses of phytoplankton community structure will be collected quarterly (Table 1) at Stations JR1, JR5, JR7, JN1 and TI1 in the James River, Stations FG2, FG3 and FG4 in Farrar Gut, and at both quarry stations, Q1 and Q2 (Figure 1). In tidal freshwater environments such as the James River in the vicinity of Chesterfield Power Station, tidal fluctuations would be expected to show minimal influence on the planktonic community structure (Dr. Harold G. Marshall, Old Dominion University - personal communication), therefore sampling will not be correlated with a particular tide cycle. Tidal conditions will, however, be documented for each survey. Water samples will be collected using the same 3 meter PVC pipe used to collect nutrient samples, thus representing an integrated sample including the euphotic zone. Two (2) replicate 500 ml subsamples will then be preserved with Lugol's solution. In addition, Secchi depth and pH will be measured at each station. The replicate subsamples will then be examined microscopically for determination of taxonomic composition, algal concentrations (cells/liter) and cell volume (cubic microns/microliter).

Although phytoplankton biomass estimates based on chlorophyll (a) measurement are relatively imprecise, they sometimes provide additional insight into the relative amount of standing crop (U. S. EPA 1973). Therefore, in addition to characterization of the phytoplankton community by microscopic examination, the chlorophyll (a) content, adjusted for pheophytin (Standard Methods 10200H), will also be measured through collection of samples quarterly.

Zooplankton

Zooplankton represent the first consumer level of the aquatic food chain and are especially important in the diets of young-of-year fishes and some species of adult fishes (Jensen 1974).

Seasonal cycles of zooplankton abundance are dependent on food supply (algae, protozoa, bacteria and detritus) and temperature (Edmondson 1965; Pennak 1978). Zooplankton samples will be collected quarterly (Table 1) at Stations JR1, JR5, JR7, JN1 and TI1 in the James River and at Stations FG2, FG3 and FG4 in Farrar Gut (Figure 1) concurrent with the nutrient and phytoplankton sampling schedule. Three replicate vertical tows from bottom to surface will be made at each midchannel station using an 80 micron mesh Wisconsin plankton net with the depth recorded for determination of sample volume based on net dimensions. Samples will be preserved with formalin/rose bengal dye and returned to the laboratory for microscopic examination and determination of taxonomic composition and relative densities (number/cubic meter).

Benthic Macroinvertebrates

Benthic macroinvertebrates will be monitored to represent a sessile component of the riverine biota. Aquatic macroinvertebrates are considered to be excellent indicators of environmental stress due to their lack of mobility, sensitivity to various environmental perturbations, and extended life cycles (Hynes 1965; Lehmkuhl 1970; Cairns and Dickson 1971). Benthic macroinvertebrate populations will be surveyed quarterly (Table 1) using an Ekman dredge at Stations JR1, JR5, JR7, JN1 and TI1 in the James River, and at Stations FG2, FG3 and FG4 in Farrar Gut (Figure 1). Substrate in this area of the river generally consists of a mixture of silt, sand, clay and organic detritus (Jensen 1974), and the Ekman dredge represents the most efficient gear for sampling substrates of this type (Flannagan 1970; Howmiller 1971; U.S.EPA 1973). Samples will be collected near shore to avoid areas dredged for ship passage, and from similar substrate types. Substrate type will be characterized and this information included in the station to station comparisons. A total of three grabs will be collected per station. Each grab will be washed through a #30 mesh sieve, placed in a jar and labeled. The sample will be preserved with 80% ethyl alcohol and stained with rose bengal dye. In the laboratory, samples will be hand-sorted, identified to major taxa and enumerated for calculations of abundance at each station (average number of organisms/square meter). Since benthic macroinvertebrates are sessile, sampling will not be correlated with any particular tide cycle.

Juvenile and Adult Fishes

Fish populations represent the upper component of the food chain. Fish have the capability to adapt to changes in their thermal regime via their mobility. Jensen (1974) found that the relative abundance of fishes in the study area varied seasonally and in response to thermal effluent. Boat electrofishing will be utilized to monitor the littoral component of the fish population, while bottom-set experimental gill nets will be used to monitor the offshore component. Electrofishing has been utilized in stream sampling to characterize species composition, relative abundance, size distribution and population structure and is considered more efficient and less biased than other sampling methods (Woolcott et al. 1974; Catchings et al. 1984). Gill nets are often used to sample fishes at depths not effectively sampled by boat electrofishing. Gill net data are not as quantitative as electrofishing data, but can be used to identify the presence or absence of species not vulnerable to electrofishing and as an indicator of relative abundance (Little et al. 1984). Fish sampling will be conducted seasonally (Table 1) to accurately represent the presence of fish within Farrar Gut and the James River. Boat electrofishing surveys will be conducted at Stations JR1, JR5, JR7, JN1 and TI1 in the James River, at Stations FG1, FG2, FG3 and FG4 in Farrar Gut, and at quarry Stations Q1 and Q2 (Figure 1). At each station one hundred meters of shoreline will be electrofished. Selected gamefish and larger rough fish will be measured (total length in mm) and weighed (weight in grams), and released in the field. The remainder of the catch will be preserved and returned for laboratory processing and determination of the species composition and relative abundance of fish per station. As recommended in the U. S. EPA's 316 (a) Technical Guidance Manual (1977), three species will be considered as "Representative Important Species" (RIS) warranting more detailed study. These species include largemouth bass (Micropterus salmoides) and channel catfish (Ictalurus punctatus) as important game and commercial fish species representing the top of the aquatic food chain and with varying life history requirements according to age, and gizzard shad (Dorosoma cepedianum) which, while not commercially important, does represent a forage fish species when young and is susceptible to thermal shock. Particular attention will be focused on the relative abundance of these species in Farrar Gut, the mainstem James River and its oxbows and in the two quarry locations,. An experimental anchor tagging study of bass and catfish will be conducted to determine residency and seasonal distributions (gizzard shad are too fragile to tag). In addition, length frequency, annual growth in length, and body condition (relative weight - Wr) will be examined for each RIS species to identify any thermal effects on growth history. Reproductive success will be assessed based on length frequency results, body condition and observation of any spawning behavior (i.e. nesting activity or spawning congregations).

In addition to electrofishing, experimental gill nets will be deployed at Stations JR1, JR5, JR7, JN1 and TI1 in the James River and Stations FG1, FG3 and FG4 in Farrar Gut (Figure 1) for a period of up to six hours. The length of the net sets may require adjustment dependent upon fish and debris catch rates determined at the beginning of the study. The experimental gill nets will be approximately 100 feet long and 6 feet deep with panels of 1-1/2", 2", 2-1/2", 3" and 4" stretch monofilament mesh. Any large fish exhibiting minimal net damage will be measured, weighed and released in the field, while the remainder of the sample will be processed at the laboratory. Gill net results will be reported as catch per unit effort (hours) and used to supplement taxonomic characterizations among stations.

As part of the fishery assessment, a literature search and communication with regional ichthyologists will also be conducted to identify any endangered, threatened or species of special concern that could possibly occur in the study area. It is recognized that at least one species of special concern, the Atlantic sturgeon (*Acipenser oxyrhynchus)* uses the tidal James River as a nursery ground (Jenkins and Burkhead 1994). However, abundance appears to be very low: only 35 juvenile sturgeon were captured in extensive trawl surveys conducted by the Virginia Institute of Marine Science between 1964 and 1982. Juvenile sturgeon might inhabit hard-bottomed areas of the lower James River for up to three years, although the distribution and life history of Atlantic sturgeon in the Chesapeake Bay region is poorly understood (Gilbert 1989). In the unlikely event that a juvenile sturgeon is captured in the course of this study, it will measured and released and the Virginia Department of Game and Inland Fisheries will be notified.

Habitat Formers

Aquatic vegetation can serve as important nursery areas for fish and other aquatic organisms. The type of vegetation present can also reduce forage availability for piscivores, result in oxygen depletion and create a nuisance for boating and recreational opportunities. The abundance and distribution of aquatic plants can be influenced by a variety of factors including nutrient levels, temperature, turbidity, siltation and current velocity. Annual summer visual surveys by boat of the study area will be conducted to identify aquatic plant communities. The data will be used to document the size, distribution and composition of the aquatic plant communities. The vegetative communities in Farrar Gut, the mainstem James River, and the Jones Neck and Turkey Island oxbows will then be compared.

Vertebrate Wildlife

The presence and estimated abundance of vertebrate wildlife usage of the study area will be documented by visual observation. In addition, concentrations of waterfowl and other vertebrate wildlife observed during the biological monitoring surveys will be documented.

Other

Station operating data will be provided to include station load, circulating water pump operation, and an assessment of chemical usage and discharges (e.g., chlorine). Also, hydrologic information associated with the study area will be presented including a description of the upstream and downstream tidal excursion.

## SCHEDULE AND FINAL REPORT

Data collection will be initiated the first quarter of 1997, assuming there are no major concerns with the study plan by DEQ. It is anticipated that, at a minimum, a progress review meeting with DEQ will be requested after the first year of data collection to evaluate the status of the demonstration and determine if changes are recommended for the second year. The Virginia Department of Game and Inland Fisheries (John Kauffman) has agreed to participate in the 316(a) study in an advisory capacity and should be invited to any progress review meetings.

The final report resulting from this study will present two years of data on all biotic components, thermal and nutrient dynamics, and plant operating conditions. Appropriate comparisons will be made between similar habitats (main river, oxbows, and quarries) within versus outside the thermal mixing zone. The narrative of this demonstration will synthesize this information with the relevant literature base to comprehensively assess the effects of CPS thermal discharges on the aquatic community of the James River.

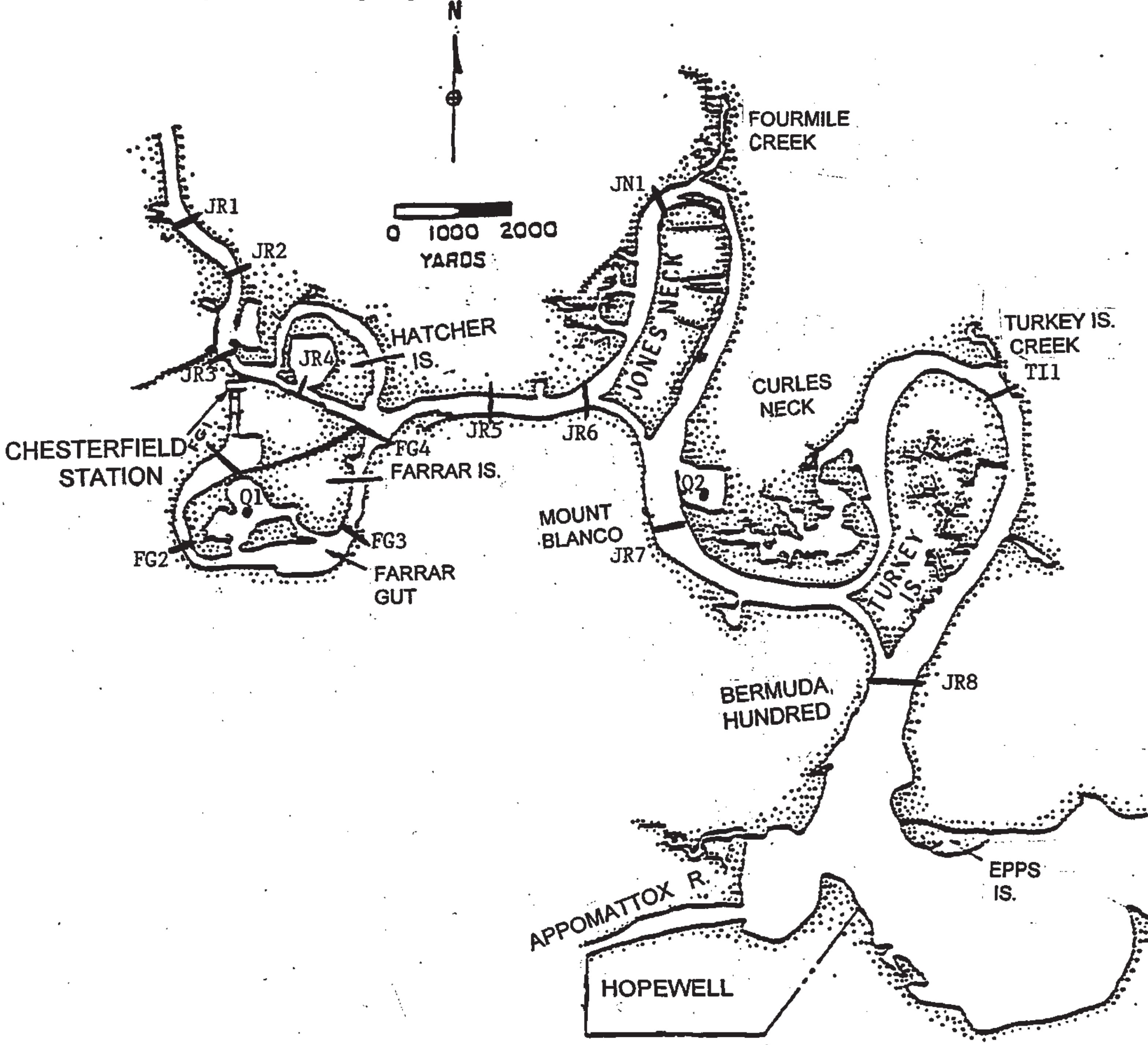
The 316(a) study will provide the scientific information to determine whether the existing thermal limitations and requirements are more stringent than necessary to protect the aquatic community. It is understood that any new heat rejection limitations proposed after the study will be based upon the results of the demonstration including necessary predictions to account for any differences between the limitations requested and actual operational levels.

TABLE 1: **Sampling Dates by Discipline in the James River, Chesterfield Power Station**

| | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | F | M | A | M | J | J | A | S | O | N | D |
| Temperature/DO | | X | | X | X | | | X | | X | X | |
| Nutrients | | X | | | X | | | X | | | X | |
| Phytoplankton/Chlorophyll(a) | | X | | | X | | | X | | | X | |
| Zooplankton | | X | | | X | | | X | | | X | |
| Benthics | | X | | | X | | | X | | | X | |
| Fish | | X | | X | X | | | X | | X | X | |
| Habitat Formers | | | | | | | | X | | | | |
| Vertebrate Wildlife | | * | | * | * | | | * | | * | * | |

* incidental wildlife observations to be recorded in field notes during regular sampling.

FIGURE 1: Approximate Sampling Locations, Chesterfield Power Station, 316(a) Demonstration.




| | JR1 | JR2 | JR3 | JR4 | JR5 | JR6 | JR7 | JR8 | JN1 | TI1 | FG1 | FG2 | FG3 | FG4 | Q1 | Q2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature/Dissolved Oxygen | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Continuous Temperature Recorders | X | | | | X | | | | X | X | X | | X | X | | |
| Nutrients | X | | | | X | | X | | X | X | | X | X | X | | |
| Phytoplankton/Chlorophyll (a) | X | | | | X | | X | | X | X | | X | X | X | X | X |
| Zooplankton | X | | | | X | | X | | X | X | | X | X | X | | |
| Benthic Macroinvertebrates | X | | | | X | | X | | X | X | | X | X | X | | |
| Electrofishing | X | | | | X | | X | | X | X | X | X | X | X | X | X |
| Gill Netting | X | | | | X | | X | | X | X | X | | X | X | | |

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# ANALYSIS OF THE INCIDENCE OF FISH MORTALITIES IN THE VICINITY OF THE CHESTERFIELD POWER STATION

A Report to Virginia Power

by

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June 1996

## INTRODUCTION

Virginia Power operates a six unit (1,750 MW total rating capacity) coal-fired generating station on the James River near Chesterfield, Virginia. Cooling water is withdrawn from the James River, and the heated effluent is discharged to the river (three units) and to Farrar Gut (three units), a 3.5 mile backwater loop connecting to the James River downstream of the station. Heated water enters the upstream end of Farrar Gut through a 1,750-feet discharge canal. Since 1971, the discharge canal has contained 128 floating spray units (termed "spargers") intended to dissipate waste heat into the atmosphere, reducing the $\Delta T$ of the discharge entering the Gut. The James River at Chesterfield is fresh water under tidal influence (average of 2.9 ft. differential between high and low tides).

Sightings of dead fish in Farrar Gut have been reported on several occasions over the 35-year operating history of CPS. The most recent die-off occurred during the winter of 1996, prompting questions about the impact of CPS operation on the fish community of Farrar Gut. At this time, Virginia Power is questioning the cost effectiveness of continued operation of its sparger complex in the CPS discharge canal. The Company is concerned whether termination of sparger operations would adversely affect the fish community of Farrar Gut.

This paper addresses the concerns regarding past fish mortalities in Farrar Gut and the potential incidence of such mortalities in the future. Specific objectives of this paper are to:

1) Identify the probable sources of past reported fish mortalities in Farrar Gut.
2) Evaluate the impact of these losses to the balanced, indigenous community; and
3) Assess the potential influence of discontinuance of sparger operations on the frequency and magnitude of future fish mortalities.

The paper represents my objective professional assessment of the impact of the operation of Chesterfield Power Station on the fish community of Farrar Gut. This assessment is primarily derived from the sources of information listed below.

## SOURCES OF INFORMATION

Inputs to this paper include data and reports on the James River/CPS/Farrar Gut physical and biological characteristics provided by Virginia Power, the Department of Environmental Quality (DEQ), the Virginia Department of Game and Inland Fisheries (VDGIF), and the Virginia Marine Resources Commission (VMRC). This information was supplemented by personal communication with DEQ and VDGIF personnel as well as with Dr. Gregory Garman, Professor of Biological Science at Virginia Commonwealth University.

A third major source of information for this paper is the published scientific literature, most particularly on the thermal tolerances of fish and the ecology of resident species. Finally, I draw on my own experience as a professional fisheries scientist. Since 1976, I have been a faculty member at Virginia Tech, conducting research on anthropogenic impacts to fish and other aquatic biota which include consequences of hydro and steam electric power generation. Prior to employment at Virginia Tech, I was the Senior Biologist for Wisconsin Electric Power Company, investigating potential impacts on aquatic communities resulting from chlorination, fish entrapment, and thermal discharges. I also made a site visit to CPS and Farrar Gut on May 23, 1996.

In preparing this report, I have been most impressed with the spirit of ready cooperation displayed by all parties from whom I asked assistance. I am particularly grateful for the inputs provided by Mark Alling, Ray Jenkins and Bill Pfeifle of the DEQ staff, Dean Fowler of VDGIF, and Greg Garman of VCU.

## SOURCES OF PAST MORTALITIES

To my knowledge, five fish kills have been documented in Farrar Gut, the first in 1980, another in 1987, two in 1989, and the most recent in the winter of 1996. It is, of course, possible that other incidents of fish mortalities have occurred in Farrar Gut because no one is assigned to survey for dead fish on a continual basis. However, any such kills, if they occurred, were probably too transient and/or involved too few fish to bring attention to the event.

For each of the five reported kills, I briefly summarize the reports, including any assessments of cause. I then offer my own interpretation of probable cause, based on the information available.

July 1980

Virginia Power and State Water Control Board personnel investigated a fish kill in Farrar Gut that occurred about July 16 (internal report from A.C. Cooke to J. M. White, Jr.). At least 14 species were included in this kill, predominantly catfish, gizzard shad and shiners, probably totalling in excess of a thousand individuals. The kill appeared to have occurred primarily in the vicinity of the discharge canal. Water temperatures measured on July 18 were in excess of 40° in the discharge canal and upper end of Farrar Gut and dissolved oxygen was 5.3 ppm. Mr. Cooke speculated that the kill may have occurred in response to high temperatures coupled with low overnight dissolved oxygen from nocturnal respiration by "great quantities of algae." Hypoxic conditions created by algae blooms frequently cause extensive, overnight fish mortalities in eutrophic lakes and ponds, an event termed "summerkill." It is entirely possible that a summerkill phenomenon was responsible for this Farrar Gut die-off, particularly if the late night period coincided with slack tide. Alternatively, an abrupt change in water quality (temperature or potential toxicant) of the discharge could have precipitated the kill. Whether the July 1980 fish kill was primarily due to extreme but natural conditions or anthropogenic causes cannot be determined at this time.

August 1987

Virginia Power personnel discovered approximately 1,000 dead gizzard shad in the discharge canal and made a report to DEQ (letter from B. M. Marshall to R. R. Jenkins, Jr.). Water temperature at this time was 42°C in the discharge canal, decreasing progressively to 33°C at the mouth of Farrar Gut. Water chemistry measurements noted no toxic concentrations and adequate dissolved oxygen. A Virginia Power (VP) biologist speculated that the gizzard shad (only species reported) probably died of thermal shock. This conclusion is reasonable, as the ultimate upper incipient lethal temperature for gizzard shad is 39°C (Stefan et al. 1992). However, gizzard shad avoid temperatures in excess of 37°C (Williamson and Nelson 1985) and should not have been present in the discharge canal at this time. A sudden rise from $\leq$ 37°C to 42°C in effluent temperature could have produced heat shock, but discharge temperatures immediately prior to the kill were not recorded. Consequently, the cause of this kill is probably heat shock, but the events that produced its occurrence cannot be determined.

March 1989

An internal VP report (later reported to DEQ) found an estimated 2,000 dead fish in the discharge canal on March 27, 1989. The majority of these were gizzard shad with some channel catfish. Temperature in the discharge canal was 24°C. The reporting biologist speculated that a chlorine overdose may have caused this kill, as the temperature was near the preferred level of both species and no evidence of toxicants was found. In the absence of data on discharge water quality when the kill actually occurred (March 24 or 25), this explanation is reasonable.

May 1989

On May 2, 1989, approximately 3,500-5,000 dead fish were discovered in the discharge canal (report from B. M. Marshal to R. R. Jenkins, Jr.). Again, the vast majority were gizzard shad with some channel catfish. Temperature (29°C) dissolved oxygen, conductivity, and pH were measured when the fish kill was discovered and found to be well within tolerance levels. This kill was similar in all respects to the March kill, except that excess chlorine discharge was not implicated. After the March die-off, daily inspections of the chlorine feed system were implemented and chlorine discharge was maintained at target concentrations. Speculation was offered that the gizzard shad may have died from stress associated with spawning (in combination with migration into the discharge canal). This explanation is not completely satisfying. Gizzard shad do not normally experience post-spawning mortality, although cold-induced winter die-offs are common throughout the species range (Becker 1983; Adams et al. 1985). However, spring die-offs of gizzard shad may occur prior to spawning if the adult fish have experienced starvation (Adams et al. 1985). The condition and spawning status of the shad killed in this incident were not described. Additionally, the pre-stress explanation does not account for the mortality of channel catfish. It appears more probable that some rapid change in water quality within the discharge canal precipitated this kill. Without constant monitoring of water chemistry parameters, it is impossible to confidently attribute this kill to any particular agent or cause.

Winter 1996

Unlike the fish kills in the 1980s, this die-off in Farrar Gut occurred several times between January and early March. I do not have documentation of the total magnitude of these kills, but at least 99% of the observed dead fish were gizzard shad, with some channel and blue catfish as well as yellow perch (Mark Alling, DEQ, personal communication).

Water chemistry monitoring in February revealed no lethal levels of toxic substances (Bill Pfeifle, DEQ, personal communication). Rather, the almost certain immediate cause of death was cold shock, a result of the unusual winter weather of 1996 and tidal action in Farrar Gut. Any person who has lived in Virginia for several years appreciates that the winter of 1996 was abnormal for its heavy snowfalls and prolonged cold temperatures. A snowfall of 30 inches blanketed much of the James River watershed in early January, followed by a rapid melt-off and flooding near the end of the month. The same sequence of events (high snowfall, rapid melting, flooding) was repeated in February. The infusion of huge amounts of cold meltwater depressed water temperatures in the lower James River for much of the winter. Thermal monitoring data from the James River in the vicinity of CPS substantiate the extreme temperature depression that occurred during the winter of 1996. January water temperatures measured by VP personnel at a station about one mile upstream of the CPS mixing zone boundary ranged between 2.7 and 6.4°C over the 1992-95 period, but dropped to 0.5°C in January 1996. Monthly temperature measurements made by DEQ personnel near this site (Buoy 157) between 1986 and 1995 were never lower than 2.5°C.

At high tide, James River water invades Farrar Gut, pushing up towards the discharge canal. The middle and lower sections of Farrar Gut consist alternately of warm water from the discharge canal at low tides and, in winter, colder James River water at high tides. The rapid change in temperature at specific locations provides the potential for cold shock for fishes that are resident in those locations.

A DEQ study of water temperature distributions in Farrar Gut conducted in February 1996 provides an excellent illustration of the cold winter/high tide effects. On February 26-28, temperature transects showed that water temperature decreased only 3°C (from 19°C to 16°C) from the discharge canal to the confluence with the James River at low tide, but 9°C (from 19°C to 10°C) at high tide. The $\Delta T$ between low and high tides progressively increased down the Gut, averaging only 1°C for the first mile below the discharge canal but reaching 7-8°C at a station 0.5 miles above the confluence. At this latter station, readings made twice per hour over the two-day period showed temperature shifts of as much as 10°C (between 21° and 11°C) occurring within 1-2 hour time frame, in response to tidal flows. Thus four precipitous temperature shifts (two up, two down) occurred daily during this period.

Each of these temperature differentials was probably not sufficient in itself to induce cold shock mortality in gizzard shad and other fishes, but the repeated exposures likely caused death in some fish. Thermal bioassays indicate that the zone of tolerance for fish acclimated to one temperature then exposed to a second is rather large (Figure 1). The temperature criteria promulgated to protect all fish against cold shock in thermal plumes (USEPA 1986) indicates that fish can tolerate temperature differentials of 15°C when the discharge is 25°C and ambient water is 10°C, and 13°C when the discharge is 20°C and ambient water is 7°C (see Figure 2). My review of the thermal tolerance literature (Coutant 1973; Becker et al. 1977; Houston 1982) supports this interpretation. For example, Otto and Rice (1974) found that yellow perch abruptly transferred from 20°C to 10°C water responded only by slowing swimming speed. Perhaps even more relevant to this paper, Cox and Coutant (1976) reported that adult gizzard shad suffered only 10% mortality when transferred from 20°C to 7°C ($\Delta T = 13°C$).

The DEQ temperature/tide study of February 26-28, 1996 in Farrar Gut showed temperature shifts that did not exceed single-dose tolerance limits or low lethal thresholds. The fish kills that occurred in Farrar Gut during the winter of 1996 resulted either because: 1) at some times, the temperature shift was even more pronounced; 2) low lethal thresholds were sometimes encountered (about 3°C for gizzard shad; Williamson and Nelson 1985); or 3) multiple exposures to temperature differentials induced death. Temperatures below the incipient lower lethal limit probably did not occur in Farrar Gut because of the mixing of heated discharged water with ambient river water. Lower high-tide temperatures than recorded in the DEQ study may have occurred when James River temperatures plunged to near 0°C, but the heated discharge temperatures should have dropped concurrently, keeping the $\Delta T$ similar. It is most probable that multiple exposures to rapid temperature differentials were responsible for the fish kills in the winter of 1996. However, to my knowledge, the response of fish to repeated, abrupt temperature change has not been described.

**Synopsis**

The four fish kills reported in the 1980s in Farrar Gut were short-term events that occurred in the discharge canal, most probably as the result of some rapid but undocumented natural or anthropogenic change in water quality. Occurrence of the 1987 and 1989 kills within a 20-month time frame 7-9 years ago suggests that they may be due to an operational malfunction which has since been corrected.

The winter of 1996 fish kill differed from the earlier die-offs in that it was: a) a prolonged, multi-episodic event; b) did not happen in the discharge canal; and c) was almost certainly due to cold shock. This fish kill was a response to the extreme climatological conditions of the period. Although tidally-induced temperature shifts must occur within Farrar Gut every winter, their magnitude is inadequate to induce large-scale mortality. Thus, the winter 1996 fish kill should also be viewed as an anomalous event.

However, there is no guarantee that another fish kill will not occur again at some date in Farrar Gut, as a function of weather, plant operation, or the condition and behavior of the fishes themselves. The question that attends documentation and attribution of recorded and potential kills is their impact, both to the balanced indigenous community and to the human users of the James River fishery resource.

## SIGNIFICANCE OF FISH KILLS

In all but the first documented cases of fish kills in Farrar Gut, the dominant species affected (usually at least 99% by number) was gizzard shad. Other species identified included channel and blue catfish, and yellow perch, but these occurred in lower numbers and the impacts of their loss on the community and fishery should be correspondingly slight.

This aspect of my analysis consequently focuses on gizzard shad. There is anecdotal evidence that some of the dead shad may actually have been threadfin shad, a close relative. The threadfin shad in the James River is an introduced species and a marginal member of the fish community because of its poor tolerance of low (< 9°C) water temperatures (Jenkins et al. 1993; Strawn 1965); it will not be considered further.

The gizzard shad is the leading candidate to be a victim of fish kills in the James River due to its high abundance and thermal fragility. The gizzard shad ranges throughout the Mississippi and Atlantic Coast drainages from the southern Great Lakes to the Gulf of Mexico (Williamson and Nelson 1985). It is subject to massive winter die-offs (exclusive of those that might be associated with heated discharges) throughout its range (Adams et al. 1985). In Virginia reservoirs, die-offs of gizzard shad are a predictable consequence of relatively severe winters (Ney et al. 1988). In northern waters, the abundance of gizzard shad populations fluctuates dramatically with the severity of the winter (Becker 1983).

Gizzard shad thrive in warm, shallow, turbid, and mud-bottomed water, such as the James River, where their number can become exceedingly high (Miller 1957). In many freshwater lakes and reservoirs, gizzard shad can overpopulate, accounting for more than half the total biomass of fish (Noble 1981). This shad is often regarded as a pest species, and some states have active shad control programs (Becker 1983).

The relative contribution of gizzard shad to the James River fish community has not been quantified. The species is "one of the most abundant, if not the most abundant fish" in the tidal James River (Dean Fowler, VDGIF, personal communication). Electrofishing surveys in the Richmond area found gizzard shad to be the most abundant species, comprising 22% by number of the total catch (Garman and Smock 1988). This relative abundance is much higher than that reported by Jensen et al. (1974) for the James River. However, this Johns Hopkins study sampled fish by seining and trapping, ineffective techniques for gizzard shad.

The economic value of gizzard shad to humans is limited to industrial (animal feed, fertilizer) commercial uses; its flesh is tasteless and bony (Becker 1983). Preliminary commercial harvest statistics compiled by the VMRC show average annual landings for 1990-95 of James River gizzard shad at 520,000 lbs (about 1,000,000 fish) worth 10¢/lb. (total of $52,000/year).

The ecological value of the gizzard shad is as a forage fish for piscivorous sport and commercial fishes. As a forage species, the gizzard shad is low on the food chain (periphyton, detritus, phytoplankton, and zooplankton) and very prolific. However, it rapidly outgrows the ingestibility limits of most of its predators (often within a few months after hatching) and can thus block much of the energy flow to the top of the trophic pyramid (Ney 1981; Ney and Orth 1986). Gizzard shad have also been indicted in the suppression of recruitment of bluegill and largemouth bass, through trophic competition with young-of-year (Dettmers and Stein 1992; Noble 1981). Indeed, there is some evidence that highly abundant adult gizzard shad can suppress production of their own progeny (Swingle 1950). Conversely, low number of adults can beget large year classes of offspring (Miller 1957).

In summary, gizzard shad are highly abundant in the James River, sustain a low-value commercial fishery, and serve the community function of energy transfer when young. However, the gizzard shad soon outgrows most of its predators and can suppress recruitment of sportfish species. Despite characteristic large-scale winter die-offs, the gizzard shad is extremely resilient.

In appreciation of this combination of traits, the die-off of even several thousand gizzard shad, as has occasionally occurred in Farrar Gut, can only be interpreted to have negligible costs, both economic and ecological, and may actually be beneficial to the balanced indigenous community.

## POTENTIAL FOR FUTURE FISH MORTALITIES

Elimination of sparger operation will raise the discharge temperature into Farrar Gut to some extent, which in turn raises concerns about thermal shock impacts on the fishes that use that area. The potential for such impacts is largely a function of the extent to which discharge temperature will be further elevated.

Continuous temperature measurements were made by VP personnel at the entrance and exit of the discharge canal between February 14 and August 7, 1989, and between July 24 and October 2, 1995. The difference between entrance and exit temperatures is primarily due to heat dissipation by the spargers. In 1989, the average temperature differential was 0.33°C while in 1995, the average differential was 0.91°C.

Fishes will seek their preferred water temperature, and attempt to avoid both high and low temperatures (Coutant 1977). A slight increase of discharge temperature during warmer months may cause some fish to avoid the discharge canal to a greater extent than at present, but avoidance will not result in mortality. Rather, the principal concern is for occurrence of cold shock mortality due to a higher discharge temperature and potentially greater $\Delta T$ when heated discharge and tidal inflow meet in Farrar Gut, the situation that apparently triggered the winter 1996 fish fill.

The *in situ* temperature measurements in the discharge canal during the February 14-March 16, 1989 period produced an average temperature reduction of 0.15°C, and a maximum of 0.6°C. However, only about half of the spargers were operating at this time. From this data, a worst-case winter scenario would produce a temperature difference of about 1.0°C in discharge temperature between 100% and 0% sparger operation.

An increase of 1.0°C in discharge temperature will expand the $\Delta T$ between low and high tide periods in Farrar Gut by a lesser differential because the incoming high tide will be mixing with the heated discharge to some extent. However, an addition of even 1.0°C cannot be predicted with any confidence to perceptibly increase the <u>frequency</u> of cold shock winter fish kills. Instead, the occurrence of such events is a function of extreme climatological conditions, weather patterns that produce an unusual amount of snow and/or cold, and much reduced ambient water temperatures for extended periods. The <u>magnitude</u> of any future cold-shock kill could be greater without the spargers to the extent that a $\leq$ 1.0°C increase in the $\Delta T$ exceeds the tolerance zone of resident fishes. Undoubtedly, many James River fishes use Farrar Gut as a thermal refuge in the winter, but only the gizzard shad has suffered large kills. An increase in $\Delta T$ of $\leq$ 1.0°C in extreme winter might then increase the shad die-off to a slight degree, particularly if cold weather is prolonged. However, the loss to date of gizzard shad has had a negligible impact, and discontinuance of sparger operation cannot be expected to discernibly affect the shad population nor its function in the community.

## SUMMARY AND CONCLUSIONS

Of the five documented fish kills in Farrar Gut, four were short-term events in the vicinity of the discharge canal and were probably due to some rapid but transient change in water quality. The most recent kill, during the winter of 1996, differed in that mortality occurred over an extended period and throughout Farrar Gut. The cause of this kill was most certainly cold shock, although the exact mechanism of lethality (multiple exposures or one-time exceedance of the zone of tolerance) cannot be determined. The magnitude and extent of the 1996 die-off can be attributed to the unusual severity of the winter, which reduced ambient water temperature in the James River for extended periods.

Four of the five fish kills were dominated by gizzard shad. This species is a very abundant and resilient fish with a history of thermal fragility over its wide geographic distribution. The commercial fishery for gizzard shad in the James River is attributable to its abundance rather than its economic value. Ecologically, the gizzard shad has an important community function as forage for piscivorous sport and food fishes, but it rapidly outgrows its predators and can suppress recruitment of young sportfish through trophic competition. The documented loss of gizzard shad in the Farrar Gut fish kills is economically slight and ecologically insignificant to the balanced indigenous community.

Projections of the effects of sparger removal on the frequency or magnitude of future fish kills is based on a further, worst-case elevation of temperature in the discharge canal of 1-2°C in summer and 1.0°C in winter. This slight increase in summer temperatures might cause some fish to avoid Farrar Gut locations for longer periods but should not result in fish kills. The frequency of winter cold shock kills will continue to be a function of extreme climatological conditions, which will far override the effect of a minute rise in discharge temperature. The magnitude of cold shock kills, if any occur, could increase for gizzard shad, the most thermally sensitive species. The additional losses should not be sufficient to discernibly affect the shad populations or the fish community.

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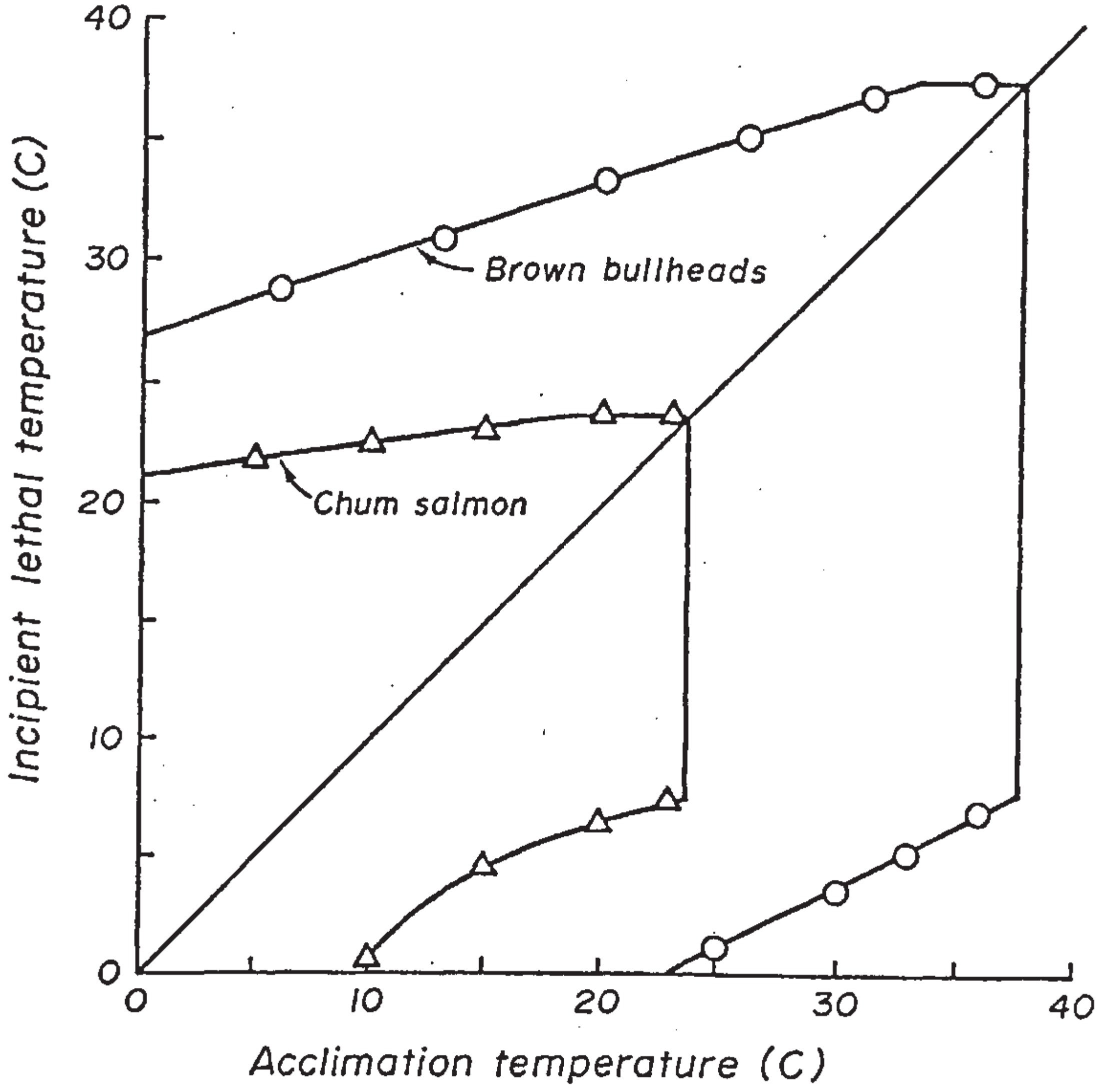


Figure 1. Thermal tolerance zones as a function of acclimation temperature. Depicted here for brown bullhead and chum salmon (from Warren 1971. Biology and Water Pollution Control. W.B. SAunders, Philadelphia).

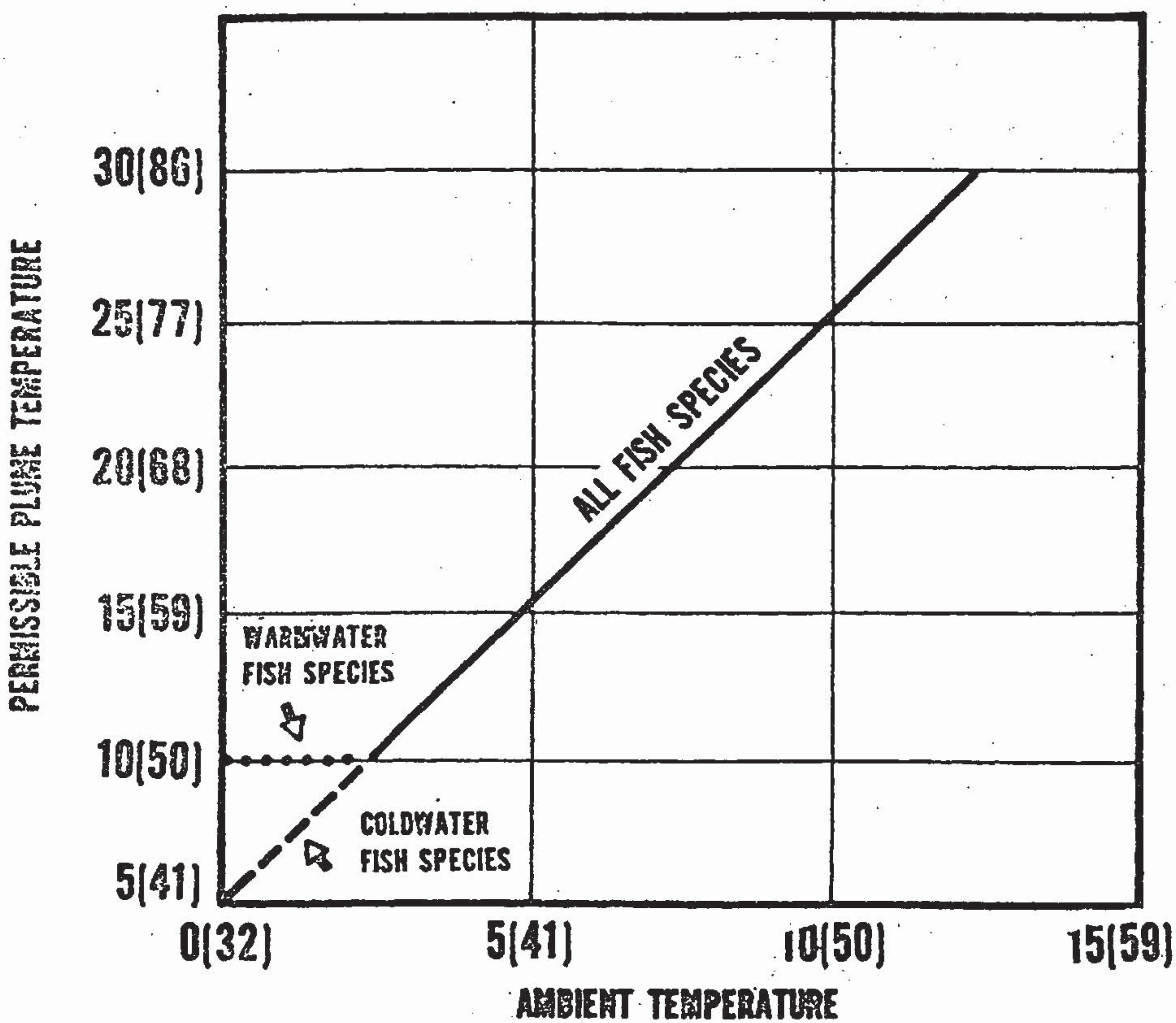


FIGURE 2. GRAPH TO ESTIMATE THE MAXIMUM WEEKLY AVERAGE TEMPERATURE OF PLUMES FOR VARIOUS AMBIENT TEMPERATURES, °C (°F). (USEPA 1986).

## Executive Summary

In October 1996, Virginia Power communicated to the Virginia Department of Environmental Quality (DEQ) its intent to undertake an environmental study at the Chesterfield Power Station in Chester, Virginia in accordance with Section 316(a) of the Clean Water Act (October 9, 1996 letter to Mr. Ray R. Jenkins of DEQ). Section 316(a) provides for facilities that have a thermal discharge into the waters of the United States to demonstrate whether current thermal effluent limitations are more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in and on the body of water into which the discharge is made.

The Demonstration was designed to characterize the interaction of thermal effluent from the station's Outfall 003 with spatial and temporal variation in nutrient concentrations, phytoplankton, zooplankton, benthic macroinvertebrates, juvenile and adult fishes, aquatic macrophytes, and vertebrate wildlife found in the vicinity of the Chesterfield Power Station. Field sampling, which commenced in April 1997 and concluded in February 1999, was conducted seasonally at sites located above and below the power station's discharge on the mainstem James River as well as in Farrar Gut (a former oxbow of the river that receives the Outfall 003 discharge) and in oxbows downriver of Farrar Gut. In addition, two flooded quarries connected to Farrar Gut and the Jones Neck Oxbow, respectively, were sampled. The study makes extensive use of comparisons among sampling locations as well as to results obtained by Jensen (1974) from similar measurements taken during 1968-1971.

Physical Components

Seasonal variation in water temperature followed ambient air temperatures. Thermal influence of the discharge of Outfall 003 was most prominent in the upper reaches of Farrar Gut with the downstream extent of the thermal plume influenced by the direction of tidal flux. The mixing of thermal effluent with tidal waters that occurs in Farrar Gut greatly reduces thermal influence on the mainstem James River.

Dissolved oxygen measurements showed no evidence of summer oxygen sags which were reported by Jensen (1974) thirty years ago. The measurements further demonstrate that oxygen levels were adequate for fish even in the hottest parts of the summer. Results of this study and other recent work (Alden 1997) show that water quality initiatives in the early seventies including improvements in controlling point source pollution have resulted in improved dissolved oxygen levels in this section of the James River.

Nutrients

Nutrient concentration values from this study also showed that water quality has increased markedly since the Jensen (1974) study with reduced concentrations of total phosphorus and ammonia. In general, the results of this study show that nutrient concentrations increased from upstream to downstream and were stable in Farrar Gut. Further, samples collected near the station's intake and 003 Outfall were similar suggesting that the power station did not alter concentrations of nutrients.

Chlorophyll *a* - Phytoplankton

Concentrations of phytoplankton and chlorophyll *a* in rivers reflect a combination of nutrient availability, turbulence, light availability, turbidity, washout, and consumption by grazers and therefore are quite variable. Nevertheless, chlorophyll concentrations in Farrar Gut were very similar to those from the James River. The overall trend among stations was an increase downstream. Values from the oxbow stations and quarry stations, however, were considerably higher than the river stations, perhaps reflecting differences in all the factors listed above. Algal abundance and biovolume values were highly correlated with, but more variable than, the chlorophyll concentrations.

Taxonomic analyses of algal abundance and biovolume by Dr. Harold Marshall (Old Dominion University) revealed an extremely diverse assemblage (100 taxa) of algae dominated by green algae and diatoms. Seasonally, a spring bloom of diatoms was replaced by summer dominance by green algae, followed by bluegreen algae into October, followed by a resurgence of diatoms and green algae. Higher algal abundances in Farrar Gut were correlated with the increased temperatures there, but there was no corresponding taxonomic composition shift. Algal abundance in this study frequently exceeded values reported by Jensen (1974) for 1970 and 1971, despite lower nutrient concentrations, suggesting improvements in water quality since the Jensen study and that the power station has no adverse effects on the phytoplankton community.

Zooplankton

Zooplankters represent the first consumer level of the aquatic food chain and are especially important in the diets of young-of-year fishes and some species of adult fish. Therefore, variation in their seasonal and spatial distribution and abundance are important to the functioning of the system. A total of 25 zooplankton taxa was collected with the rotifer group being the most diverse taxonomically. Rotifers were also the most abundant zooplankters collected, with the copepod and cladoceran groups (crustacean zooplankton) ranked second and third in abundance, respectively. Crustacean zooplankton abundance was much higher (+427%) than that from 1968-1971 reported by Jensen (1974). Rotifer abundance was not reported by Jensen (1974), therefore comparisons to rotifer abundance in this study could not be made.

During summer, zooplankton community structure was less diverse in upper Farrar Gut (station FG2) than at other locations while diversity indices in lower Farrar Gut better approximated those from mainstem river and oxbow stations. In fact, diversity at both lower Farrar Gut stations exceeded or equaled that of the Jones Neck Oxbow in August 1997 and July 1998. For the remainder of the year, improvement in the zooplankton community structure was evident at FG2 with diversity exceeding that of downstream stations in Farrar Gut, mainstem river and oxbow stations on some occasions.

Zooplankton density typically increased from upstream to downstream and was highest during summer months. Zooplankton density was consistently and significantly lower at James River station JR1, located on the upstream boundary of the study area, than at all other stations. Zooplankton abundance at FG2 was consistently greater than at JR1, yet also significantly less than most of the remaining sites; however, zooplankton densities were highest at FG2 during summer months. Zooplankton densities increased downstream in Farrar Gut to the point that zooplankton abundance in the lower gut (FG4) was not significantly different from that of the mainstem river or oxbows.

Taken together, these results suggest that the zooplankton community is significantly healthier than it was in the early seventies (Jensen 1974), and the power station does not negatively impact this ecosystem component.

Benthic Macroinvertebrates

Because of their sessile nature, high reproductive rates, and relatively long life spans, benthic macroinvertebrates can serve as indicators of environmental health/stress. As in Jensen's (1974) previous study, the benthic community in the tidal region of the James River in the vicinity of Chesterfield Power Station was dominated numerically (98%) by Oligochaeta (worms) and Chironomidae (midges). However the nymphs of the oxygen-sensitive mayfly *Hexagenia* were collected during all months sampled in the current study, suggesting that water quality has significantly improved since Jensen (1974) did his surveys. Seven of eight sampling locations had similar abundances of benthic macroinvertebrates, and overall benthic abundance increased from upstream to downstream, similar to algae and zooplankton (see above). Benthic density at station FG2 was significantly ($P<0.05$) lower than all others, possibly due to its proximity to the 003 thermal discharge. Samples from Farrar Gut stations FG3 and FG4 had approximately 10 times as many macroinvertebrates as did FG2, and did not differ from mainstem James River or oxbow stations.

<u>Juvenile and Adult Fishes</u>

Fish are considered the most critical component of aquatic biota in assessment of impacts from cooling water discharges because fish represent the upper levels of the food web and so reflect the health of the lower levels. Their tremendous popular appeal for recreational, commercial, and aesthetic reasons causes the public to view the status of the fish community as indicative of the health of the aquatic ecosystem. Therefore, extensive electrofishing and gillnet surveys of fish abundance were conducted, with special analysis of largemouth bass, channel catfish, blue catfish and gizzard shad as "representative, important species". Within the electrofishing samples, gizzard shad, threadfin shad, bluegill sunfish, largemouth bass, carp, spottail shiners, and white perch were the most frequently taken taxa. The gillnet samples reflected a different fish capture selectivity, with gizzard shad, threadfin shad, white perch, blue catfish, and channel catfish the most commonly collected taxa. A total of 35 native and introduced, riverine, and estuarine species was collected. Species compositions in the current study were similar to those found by Jensen (1974) except for the increased importance of threadfin shad and the replacement of two catfish by the channel catfish and blue catfish abundant in the James River now.

Comparison of fish taken at stations within the power station's thermal mixing zone (FG1, FG2, FG3, FG4, JR5, Q1) with those collected at reference sites (JR1, JR7, JN1, TI1, Q2), showed that the thermal stations attracted fish in winter resulting in the greatest seasonally averaged abundances, with the upper reaches of Farrar Gut serving as a thermal refuge in winter. Non-thermal stations, however, had more species (7.3 vs 6.0 for electrofishing and 5.4 vs 4.1 for gillnet samples, respectively). Fish avoided waters above 35°C so fish were less abundant at the northernmost Farrar Gut stations in summer, although some were collected in gillnet samples in July 1998. Fish abundance in the lower portion of Farrar Gut (FG3 and FG4) was more similar on average to oxbow reference stations than to upper gut stations. Oxbow stations tended to have a somewhat more diverse species composition than lower Farrar Gut stations, which may be a function of accessibility and habitat. The two quarry stations had the least seasonal variability in fish abundance, a reflection of the dominance of these lake-like habitats by resident fish species such as bluegill sunfish, largemouth bass and carp. The flooded quarry off Farrar Gut averaged 4°C warmer than its counterpart off the Jones Neck Oxbow, but electrofishing surveys consistently caught twice as many fish there. Comparisons among mainstem James River stations upstream and downstream of Chesterfield Power Station demonstrated that the power station's cooling water discharge had no discernable effect on the abundance and composition of the fish assemblage in the mixing zone.

The selected Representative Important Species (gizzard shad, largemouth bass, channel catfish and blue catfish) were well distributed among the habitats sampled in fisheries surveys and showed no negative influence of cooling water discharge on growth, size distributions, or condition. Tag returns indicated that channel catfish and blue catfish were quite mobile, while largemouth bass were more likely to remain within a home range.

Infrequent fish kills in Farrar Gut have been due to a combination of causes – plant operation or malfunction, extreme weather, and the behavior and physiology of the fishes themselves. The January 1999 threadfin shad kill reflected a die-off of a species whose tolerance for cold (minimum = 9°C) is marginal for the James River. Previous kills were dominated by gizzard shad, the most abundant and sometimes ecologically problematic species in the fish assemblage. The number of shad killed is negligible relative to their abundance and these events cannot be construed to have impacted the James River fish assemblage.

Basically, the only identifiable effect on the fish component of the community found in either this study, or by Jensen (1974), was the seasonal attraction/avoidance response to the heated water.

Habitat Formers

The presence of aquatic macrophytes and the diversity of plant communities was found to be driven more by hydrodynamics than water temperature. For example, current scouring at some sites serves to reduce plants to patches of waterwillow and smartweed whereas the more-protected oxbows and Farrar Gut had the richest and most diverse plant communities, consisting of pickerelweed, wildrice, smartweed, arrow-arum, and broadleaf cattail. The thermal effluent discharged from the power station did not appear to limit establishment of aquatic vegetation in Farrar Gut or elsewhere within the thermal mixing zone.

Vertebrate Wildlife

Due to the importance of the James River to migratory and indigenous waterfowl and other birds, an informal survey of birds was performed by Virginia Power personnel as they conducted fieldwork associated with other aspects of the study. Forty species of birds within 16 families were recorded during the study. In any given month, only 15-19 of these species were observed due to the migratory behavior of most of the species present. Six species were observed throughout the study (double-crested cormorant, great blue heron, Canada goose, turkey vulture, black vulture, and bald eagle) and belted kingfishers and American crows were observed in 11 of 12 months. Birds of prey (other than the bald eagle) were among the less frequently observed with the red-tailed hawk occurring in 7 of 12 months, northern harrier (2/12 months), red-shouldered hawk (1/12 months), and broad-winged hawk (1/12 months). Overall, birds were frequently observed on the study sites around Chesterfield Power Station, with the number of birds observed at stations at Farrar Gut often exceeding those further away, even though the latter stations represented 2.5 times as many river miles as are within Farrar Gut.

Conclusions

The results found in this report provide an objective and scientific assessment of the effects of the existing thermal discharge from the Chesterfield Power Station on the aquatic community in the James River. The results from this study demonstrate that the thermal discharge from Outfall 003 does not cause appreciable harm to the overall aquatic biological community and a balanced indigenous community of shellfish, fish and wildlife does exist in the James River in the vicinity of the power station.

## 10.0 Conclusions

The objectives of this study were to firstly characterize the components of the aquatic ecosystem in the James River in the vicinity of Chesterfield Power Station, and then secondly, to assess the impacts of the station operations specifically from Outfall 003, and with the sparger system inactive, on these components. The study was conducted over a two-year period in accordance with protocol that was developed by representatives from DEQ, VDGIF, academia, and the power company. The overall intent of the study design was to provide requisite information for valid evaluations leading to informed decisions.

We are confident that all of these objectives were accomplished thanks to the oversight and input from all representatives of the team. The study results clearly demonstrate that the discharge from 003, even with the spargers deactivated, has not caused appreciable harm to the overall aquatic biological community in the James River in the vicinity of the power station to the extent of limiting or restricting the balanced, indigenous populations of shellfish, fish and wildlife. There are seasonal and very local results. For example, the fish move in and out of the immediate discharge area seasonally yet downstream of the discharge area the fish populations are comparable to other parts of the study area. Similarly the benthos are suppressed proximal to the discharge but they too recover further down Farrar Gut.

In the final analysis, the results of this 316(a) Demonstration show that the current thermal effluent limitations in the VPDES Permit VA0004146 for

Chesterfield Power Station are more stringent than necessary to assure the protection and propagation of a balanced, indigenous aquatic community in the James River in the vicinity of the station.

recaptured in the quarries in which they were tagged, two showed regional movement within the study area (JR1 to JR4, FG4 to JR4) and one, tagged at FG1, was recaptured at Hopewell six months later. Two channel catfish were recaptured near the same station at which they were tagged. Two were recaptured in Richmond, one four days after tagging. One blue catfish tagged at FG1 in January 1998 was recaptured in July at Hopewell near a paper mill; however, the temperature regime there is unknown. Based on these results, the catfish species showed a greater propensity for movement than did largemouth bass and information was limited regarding movement of RIS in response to water temperature.

**Incidence of Fish Kills**

Two fish kills (i.e., observation of a number of dead fish) occurred in Farrar Gut since this study was initiated in 1997. These are described here.

February 18, 1998 - Approximately 170 dead gizzard shad in the 4-6" range were counted in the 003 discharge canal. Cause of death is uncertain. The James River was high and turbid from rainfall the previous day. Station personnel evaluated the operation of the station to determine if there had been any upsets, spills or other unusual occurrences. None were found. Unit 6 was operating at reduced load and the station's chlorination system was not operating. Water temperature in the discharge canal at 3 p.m. was 18-19°C. At this time fish were observed breaking water and moving about the canal in apparent good health. Several anglers were fishing in the discharge canal; anglers had previously been observed collecting shad for bait in the canal with cast nets. Whether the shad were discarded bait or died from some cause associated with the recent rainfall event could not be determined. Densities of both gizzard and threadfin shad were high throughout Farrar Gut in the January 1998 electrofishing survey. Relative to their total abundance, the number of dead gizzard shad represented an insignificant and very localized mortality event.

February 26, 1999 - About 10,000 dead threadfin shad (3-5") were found in the discharge canal. Death was most likely due to cold shock after Unit 6 went off-line the previous day, reducing water temperature in the immediate vicinity of its discharge to 7°C. Units 4 and 5 remained in operation, and downstream mixing caused the temperature midway down the canal to be 17.5°C. Threadfin shad abundance was extremely high in Farrar Gut in the January 1999 electrofishing survey. Although Unit 6 had experienced 26 outages in the previous 14 months, only this particular outage was followed by a fish kill. The combination of high shad density and extreme low river temperatures appeared to interact to produce the fish kill during this outage.

An additional 5,000 dead threadfin shad were observed in the mainstem James River at the embayment next to the CPS intake screens backwash sluice; they had apparently been impinged on the vertical travelling screens, then washed off. A recent cold snap had reduced ambient river temperature to ~ 5°C. Threadfin shad are notoriously cold-intolerant, becoming stressed and ultimately dying when water temperature falls below 9°C (Strawn 1963). The low river temperature most probably killed the shad prior to impingement. It is also probable that a major die-off of threadfin shad occurred throughout the lower James River at this time.

## 7.3 Discussion

### James River Fish Assemblage

A total of 10,433 specimens was captured in the fisheries surveys, 23% by gillnet and 77% by electrofishing. The disparity in total catch reflects differences in the two gears and the nature of their deployment. Electrofishing is an instantaneous and active capture technique, while gillnets are passive, relying on movement and inability of fish to avoid the nets (Murphy and Willis 1996). In this study, gillnets were set for ~4 hours during daylight. Sets of longer duration or at night would have produced more fish (Hubert 1996). However, neither was possible in this study because of the high number of stations involved, and the safety hazard posed by night sampling on the James River.

Gillnets and electrofishing are effective and complementary capture gears. Gillnets target mobile, fusiform fish that wedge or gill in the mesh (e.g., white perch) as well as spiny fishes that entangle (e.g., catfishes). Electrofishing is most effective in surface waters (to ~ 6') and targets both sedentary (e.g., sunfish) and schooling species (e.g., gizzard shad). Electrofishing is also more effective for small fishes (e.g., shiners, young-of-year) that can pass through even small-mesh gillnet panels.

Catches by the two gears showed some strong similarities as well as expected differences. For each gear, almost half the total catch was the two *Dorosoma* species, gizzard and threadfin shad, which is indicative of their high catfish species. There was little evidence of movement of these RIS in response to water temperature.

**Incidence of Fish Kills**

Two fish kill events have occurred in Farrar Gut since 1997, and four previous fish kills have been documented since 1987. Ney (1996) investigated the nature and causes of these mortalities. His findings, as well as relevant information on the February 1998 and February 1999 die-offs, is reviewed here to identify causes and assess ecological significance.

The February 1998 kill occurred in the Farrar Gut discharge canal and involved <200 gizzard shad. No CPS unit shutdown or excess chlorine discharge preceded the finding of dead fish. It is possible that the dead shad were bait discarded by anglers.

The February 1999 fish kill involved approximately 10,000 threadfin shad in the discharge canal and about another 5,000 washed off the travelling screens at the CPS James River intake. Mortality in the discharge canal was probably due to shutdown of Unit 6, which plunged the discharge temperature to 7°C. Threadfin shad in the immediate vicinity of that effluent thus suffered lethal cold shock. However, the impingement losses should be considered a natural event. Threadfin shad cannot tolerate temperature <9°C, and the ambient James River temperature was ~5°C due to a cold snap.

One brief fish kill occurred in 1987 with two more in 1989, as well as a more prolonged die-off during the winter of 1996. These appear to have had various causes. The first event, in August 1987, involved ~1,000 gizzard shad in the discharge canal which Ney (1996) considered most plausibly due to a sudden rise in temperature and resultant heat shock. In March 1989, ~2,000 fish, mostly gizzard shad with a few channel catfish, were found dead in the discharge canal. Water temperature was in the preferred range (~25°C), and no generating unit shutdowns occurred. It is probable, however, that a sudden change in discharge water quality did happen, perhaps involving excess chlorine. A similar kill occurred in May 1989 involving ~ 5,000 fish, again predominantly gizzard shad with some channel catfish. Again, some sudden change in water quality was probably responsible, although the source could not be identified.

Fish die-offs in Farrar Gut occurred several times between January and early March 1996. Total counts of dead fish were not made, but involved at least 99% gizzard shad. Unlike previous mortality events, this one was prolonged and not confined to the discharge canal. Fish almost certainly died of cold shock, the result of an extremely cold winter and rapidly alternating water temperatures due to normal plant operation and tidal flow. At high tide, extremely cold waters pushed up the Gut, displacing the warm outflow. Temperatures in the middle and lower Gut dropped as much as 10°C within an hour, twice per day. While the bioassay literature indicates that fish can withstand one such event, death would likely occur from the cumulative stress of repeated exposures.

Review of these six fish kill events (in the past 12 years) implicates a variety of causes - plant operation (or malfunction), extreme climatic conditions, and the thermal behavior and tolerance of the fishes themselves. These have been uncommon events that primarily involved (usually >99%) gizzard shad and threadfin shad, both small, highly abundant fishes that are thermally fragile. The threadfin shad in the James River is an introduced species (native to the far southern U.S. and Mexico) that simply cannot tolerate cold winters. Wherever it exists in Virginia, the threadfin shad undergoes huge die-offs in cold winters. Because it is very prolific and can produce two generations per year, populations can rebound quickly following a mild winter. "Boom and bust" fluctuations characterize Virginia threadfin shad populations. In the "balanced indigenous community" of the James River, the threadfin shad must be considered a marginal member whose continued existence depends on the availability of winter thermal refuges, such as provided by Farrar Gut.

The native gizzard shad is also subject to massive winter die-offs throughout its broad range from the Great Lakes to the Gulf of Mexico (Adams et al. 1985). More cold tolerant than threadfin shad, gizzard shad have a lower lethal threshold of 3°C, although prolonged exposure to slightly higher temperatures can be fatal. (Williamson and Nelson 1985).

Gizzard shad are both extremely prolific and low on the food chain; they account for half the fish biomass in some lakes and reservoirs (Noble 1981). Electrofishing surveys in the James River near Richmond by Garman and Smock (1988) found gizzard shad to be the most abundant species, accounting for 22% of the total catch. In the present study, gizzard shad were 16% of the electrofishing catch and 39% of the gillnet catch (threadfin shad were 27% and 11%, respectively).

During the 1990-95 period, the Virginia Marine Resources Commission recorded annual commercial landings of James River gizzard shad averaging 520,000 lbs. per year worth $0.10 per lb. as animal feed or fertilizer. Ecologically, gizzard shad is most important as a forage fish for valued game and commercial species. However, it rapidly outgrows the ingestibility limits of most predators and can then block energy flow to the top of the food web (Ney and Orth 1986). Gizzard shad have been indicted in the suppression of sportfish populations through trophic competition with their young, and high populations of gizzard shad can suppress production of their own progeny (Swingle 1957). Conversely, low numbers of adults can produce large year classes of offspring (Miller 1957). Some states consider gizzard shad a nuisance species and have active control programs (Becker 1983).

In summary, the six reported fish kills at CPS since 1987 have been comprised predominantly of gizzard and (recently) threadfin shad numbering a few hundred to several thousand. Both were highly abundant species during the course of this study, although threadfin shad abundance is controlled by the severity of the winter and the species is, at best, a "wild card" in community dynamics. Gizzard shad sustain a low-value commercial fishery, and their forage value, while substantial, is largely limited to young-of-year. On the negative side, gizzard shad can depress early growth and survival of other fishes. Despite occasional large-scale winter die-offs, gizzard shad populations are extremely resilient.

In appreciation of these features of the two shad species, the magnitude of their losses in the Farrar Gut fish kills can only be interpreted to have had negligible costs, both economic and ecological. Otherwise, the fish kills only involved a few channel catfish, which remain abundant, along with expanding populations of the introduced blue and flathead catfishes. The infrequent fish kills that have occurred in Farrar Gut must be judged to have had no discernible impact on the balanced indigenous community of the lower James River in the Chesterfield area.

### 7.4 Conclusions

This intensive two-year field study characterized the fish assemblage of the James River in the vicinity of Chesterfield Power Station. Fish abundance and species composition were highly dynamic, among stations, seasons, and years. However, spatial and temporal comparisons described patterns of fish distribution and permitted a detailed assessment of the impacts of the CPS cooling water discharge into Farrar Gut on the fishes of the James River. The study resulted in the following conclusions:

1. The lower James River fish assemblage is a diverse mixture of native and introduced, riverine, and estuarine species, many of which are highly mobile. Of the 35 species captured in electrofishing and gillnet surveys, eight (gizzard shad, threadfin shad, bluegill sunfish, spottail shiner, channel and blue catfish, carp, white perch) constituted over 90% of the total catch. The James River fish assemblage in the Chesterfield area was previously described in a Johns Hopkins University study from 1968 to 1971. In the course of 30 years, the fish

# COMMONWEALTH of VIRGINIA

*DEPARTMENT OF ENVIRONMENTAL QUALITY*


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July 20, 2001

Ms. Pamela F. Faggert
Vice President and Chief Environmental Officer
Dominion Energy & Dominion Generation
Innsbrook Technical Center
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Glen Allen, Virginia 23060

RE: VPDES Permit No. VA0004146 – Chesterfield Power Station
316(a) Demonstration

Dear Ms. Faggert:

The staff of the Department of Environmental Quality has reviewed the 316(a) Demonstration Report submitted by your letter dated February 29, 2000, and **CH2M**Hill's "Thermal Impact Modeling Study for the Virginia Power Chesterfield Station" submitted by Bill Bolin on February 22, 2001.

The staff concurs with the conclusion stated in the 316(a) Demonstration Report that at the conditions observed during the study, the thermal discharge from Outfall 003 should not cause appreciable harm to the overall, aquatic biological community, and that a balanced, indigenous community of fish, shellfish, and wildlife exists in the James River in the vicinity of the power station. The thermal modeling report however, does not adequately predict the temperatures that will be experienced at full load (i.e., at the thermal limitation requested by Dominion) and consequently, additional thermal modeling is needed to accurately predict those temperatures. After those temperatures are predicted, an assessment must be made to determine if the conclusions of the Demonstration Report are still valid at the predicted temperatures.

As the staff has questions about some of the specific assumptions and inputs used by **CH2M**Hill in their modeling, we suggest a meeting with Dominion staff and the modeling consultant. It may be advantageous to also develop the model to evaluate pollutants such as ammonia as Dominion is pursuing authorization to discharge ammonia at Outfall 004.

Please contact Ray Jenkins at 527-5037 if you have questions.

Sincerely,

Gerard Seeley, Jr.
Regional Director

cc: DEQ – Office of Water Permit Support
DEQ – Office of Water Quality Standards
EPA – Region III (3WP12)
Mr. Martin L. Bowling, Jr. – Vice President Operations, Dominion Energy & Dominion Generation

## EXECUTIVE SUMMARY

The Chesterfield Power Station (CPS) is a fossil-fuel electric generating station on the James River east of Richmond and is owned and operated by Dominion (the Company). An extensive 316a Demonstration on the cooling water discharges for Units 4, 5 and 6 was conducted by the Company in 1997-1999 under various typical operating conditions.

Following submittal of the 316(a) Final Report the Virginia Department of Environmental Quality (VADEQ) responded with the following in a letter to the Company:

> "The staff concurs with the conclusion stated in the 316(a) Demonstration Report that at the conditions observed during the study, the thermal discharge from Outfall 003 should not cause appreciable harm to the overall, aquatic biological community, and that a balanced, indigenous community of fish, shellfish, and wildlife exists in the James River in the vicinity of the power station. The thermal modeling report however, does not adequately predict the temperatures that will be experienced at full load (i.e., at the thermal limitation requested by Dominion) and consequently, additional thermal modeling is needed to accurately predict those temperatures. After those temperatures are predicted, an assessment must be made to determine if the conclusions of the Demonstration Report are still valid at the predicted temperatures."

HydroQual, Inc. was contracted by the Company to perform the subsequent modeling study utilizing data from the 316a and comparing them to predicted values of the Chesterfield P.S. operating under the full permit load conditions of 5.55 x $10^9$ BTU/hr for Units 4, 5 and 6 and 1.78x$10^9$ BTU/hr for Units 3, 7 and 8. The three-dimensional hydrothermal model, ECOM, used in this study has the capability of predicting time variable intake, outlet and river temperatures. The present modeling analysis provides an objective and scientific assessment of the thermal discharges under full permit load conditions.

A practical, numerically efficient, accurate approach has been taken in order to discretize the entire water body including Farrar Gut and the James River within a single modeling grid framework. An orthogonal, curvilinear grid system consisting of a 46x24-segment grid in the horizontal plane was used. A transformed $\sigma$-coordinate system in the vertical plane with 11 layers allows the model to have an equal number of high-resolution vertical segments in all the computational grid boxes.

Dominion conducted a series of 24 synoptic temperature monitoring surveys from May 1997 through February 1999. Each survey measured vertical profiles at fourteen stations throughout the James River and Farrar Gut. An assessment of the available data revealed that the year 1998 has a complete set of temperature profile data covering both the winter and summer months. Therefore, the model simulation period was selected as January through December 1998. This provides an opportunity to model both the critical winter and summer months and determine the temperature rise in Farrar Gut and the James River when the plant is operating in accordance with its full permit capacity.

Different types of data were used as input to the model. Water level boundary conditions were applied at the open boundary at Eppes Island near Hopewell, VA (NOS Station 8638481), using tidal harmonics (amplitude and phase) of the S2, M2, N2, K1, P1 and O1 components. In addition to the water level boundary conditions, the model also requires temperatures at the downstream boundary at Eppes Island. Observed temperature at Turkey Island station (TI1) was used for the downstream boundary conditions. The model was also driven by daily averaged freshwater flows and associated temperature as measured at the USGS flow gage at Richmond, VA. These flows were applied at the grid cell at Richmond. Unfortunately there was no continuous record of temperature available for the Richmond gage. Therefore the temperature recorded at station JR1 during 1998 by Dominion Generation was used for the boundary temperature condition at Richmond. This implicitly assumes that the temperature at JR1 is unimpacted by Chesterfield operations for 1998. The validity of this assumption is justified by how well the model reproduces the temperature at JR1. Finally, the hydrodynamic model requires the input of wind speed and direction, air temperature, relative humidity and short-wave solar radiation. These data were obtained from the Richmond Airport meteorological station.

Chesterfield P.S. operational data were brought into the modeling framework by configuring the plant's intake and discharge flows and associated temperature in the model input module. Discharge temperatures at the condenser for Units 3, 7, and 8 were directly used in the model. However, for Units 4, 5 and 6, the discharge temperatures recorded at the condenser could not be used directly, because these units do not immediately discharge to the Farrar Gut. Plant discharges from these units are routed via underground piping to the head end of a discharge canal where a continuous temperature monitoring station, 003, was located. The heated discharges then flow to Farrar Gut through the canal. Temperature measured at the nearest monitoring station in the Gut was considered to be the true reflection of the plant's thermal discharge. It should be noted that the model requires a continuous specification of temperature at the head end of Farrar Gut. Temperature measured at FG1 was intermittent and therefore, regressions between the temperature at FG1 and Station 003, and Station 003 and the plant outlet temperatures (available hourly throughout the year), were used to fill in the missing data.

The model simulations were performed for January through December of 1998, a period that encompassed the majority of field measurements conducted by Dominion. Calibration and validation of the model have been accomplished by comparing model results against observed tidal levels and temperature in Farrar Gut and the James River. To maximize the strength of the model's skill assessment, the calibration and validation process is performed concurrently using data from twelve synoptic surveys representing the conditions in the James River and Farrar Gut during the spring, summer and the winter months of 1998. A concurrent approach of calibration and validation was adopted because the temperature data used for this study are statistically independent and they represent a wide range of meteorological and hydrological conditions including hot summer and cold winter months and high (spring) and low flow (summer) periods. The model calibration parameters do not change in time. Therefore, the degree of reliability and robustness of the model for reproducing conditions in both the James River and Farrar Gut during this wide range of seasonal atmospheric and hydrologic conditions can be most reliably assessed. Calibrating and validating the model for the entire year-1998 also encompasses a wide range of tidal (spring-neap cycle) conditions. A successful model skill assessment using data over a complete annual cycle is arguably the strictest test of model performance (Blumberg and Pritchard, 1997). Overall the model prediction of temperature during 1998 is quite good and the overall RMS error is 1.1C (2.0F). Model calibration against tidal level data was also quite good. The error is less than 1%.

The present analysis was directed at computing the temperature rise ($\Delta T$) in Farrar Gut and the James River for conditions when the plant was operating at full permit load capacity ($5.55 \times 10^9$ BTU/hr for Units 4, 5, and 6 and $1.78 \times 10^9$ BTU/hr for Units 3, 7 and 8). The model is used to perform a continuous simulation for the entire 1998 period. For analysis purposes, we isolate the periods when the synoptic surveys were conducted throughout the James River system. This is because the survey data give a very accurate depiction of conditions in the entire river as they capture both the vertical and horizontal thermal structure and seasonal temperature variations. We examine the temperature rise for the times when synoptic survey data were available during 1998 (including summer and winter months). The average temperature rise ($\Delta T$) is found to be 1.6C (2.9F) at Station FG4 during permit load conditions. Accurate temperature prediction at FG4, near the confluence of Farrar Gut and the James River is considered an important part of the model because this is the point at which the thermal loading from Outfall 003 is ultimately discharged to the James River. The average temperature rise for the entire Farrar Gut is 1.1C (2.0F) and for the James River it is 0.6C (1.2F). These temperature rises are not high enough to produce significant changes to the hydrodynamic characteristics of the James River system.

than the lower discharges of 1998 do. Figures 16a through 16c illustrate longitudinal profiles of temperatures along the James River. The highest temperature rise occurs near stations JR4 and JR5, downstream of Outfalls 001 and 002. It should be noted that waters from Farrar Gut enters the James between stations JR4 and JR5.

The average increase in temperatures due to full permit load conditions, during the synoptic survey periods, were 1.1C (2.0F) in Farrar Gut and 0.6C (1.2F) in the James River. This does not include the synoptic survey on October 22, 1998 when the Chesterfield plant was not operating. The average temperature rise due to permit load conditions at FG4 is 1.6C (2.9F). Station FG4 is a key location at which the thermal loading from Outfall 003 is ultimately discharged to the James River. These temperature rises are not high enough to produce significant changes to the hydrodynamic characteristics of the James River system.

## 9. CONCLUSION

Chesterfield Power Station is in the process of renewing its NPDES permit. Dominion has previously performed a Section 316(a) demonstration on the cooling water discharge for Units 4, 5 and 6 under various operating conditions. However, the demonstration did not focus on the combined simultaneous operating conditions of these units at full permit load. The Virginia Department of Environmental Quality (DEQ) identified the need for a modeling effort to accurately predict the temperature in Farrar Gut under full permit load conditions of $5.55 \times 10^9$ BTU/hr for Units 4, 5 and 6, and $1.78 \times 10^9$ BTU/hr for Units 3, 7 and 8.

The current study addressed the need to predict temperatures in Farrar Gut and the James River, specifically at stations where synoptic surveys were conducted under full permit load conditions. The three-dimensional hydrothermal model, ECOM, was used in this study. The model simulations were performed during January through December of 1998, a period that was sufficiently long enough to encompass the field measurements conducted by Dominion. Calibration and validation of the model have been performed by comparing model results against observed tidal levels and temperature data in Farrar Gut and the James River. The model skill assessment was demonstrated by comparing the model predicted temperature against the observations at all the stations surveyed by Dominion Generation during 1998, including the cold winter and hot summer months. Overall the model prediction of temperature for the entire period of 1998 is quite good and the overall RMS error is 1.1C (2.0F). Model calibration against tidal level data was also quite good.

An analysis of the plant data and model results indicates that the Chesterfield P.S. operating loads are quite variable in time. These synoptic data give a very accurate depiction of conditions in the entire river as they capture both the vertical and horizontal thermal structure as well as seasonal variability in temperature. The model calibration performed against these temperature profile data provides a high level of confidence in the model. The present analysis was directed at computing the temperature rise ($\Delta T$) in Farrar Gut and the James River for predicted condition of when the station was operating at full permit load capacity ($5.55 \times 10^9$ BTU/hr for Units 4, 5 and 6, and $1.78 \times 10^9$ BTU/hr for Units 3, 7 and 8). For the times when synoptic survey data were available during the entire simulation period of 1998, including the summer and winter months, the average temperature rise ($\Delta T$) is 1.6C (2.9F) at Station FG4, a key location for this study located at the confluence of Farrar Gut and the James River. Accurate temperature prediction at FG4 is considered an important part of the model because this is the point at which the thermal loading from Outfall 003 is ultimately discharged to the James River. The average temperature rise for the entire Farrar Gut is 1.1C (2.0F) and for the James River it is 0.6C (1.2F).

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**Assessment of the Thermal Impact of Full Load Operation of Chesterfield Power Plant on the Fish Assemblage of the Lower James River Based on Hydroqual's Revised Report**

by John J. Ney, Ph.D.

June 2003

I have read the revised Hydroqual report (dated April 25, 2003) *Thermal Modeling of Chesterfield Power Station on the James River and Farrar Gut, Virginia* by Blumberg, Ahsan and Li to evaluate how changes in the thermal regime due to continuous full load operation of CPS could affect the fish assemblage of the James River in the vicinity of CPS as well as of the Farrar Gut oxbow, to which three of the CPS units discharge. The updated Hydroqual report is based on revised inputs concerning the discharge point for heated effluent to Farrar Gut and maximum achievable pump flows which would be necessary to operate CPS at full load.

It is my understanding that the revised full-load $\Delta T$ projections would result in an average increase of 0.6 C in the James River and 1.1 C in Farrar Gut over temperatures actually measured at James River and Farrar Gut stations throughout 1998 as part of the CPS 316(a) demonstration.

I commented at length (March 2002) on the impacts to the fish assemblage that would be associated with the full-load thermal regime projections developed by Hydroqual in an earlier draft report. In that report, the average James River $\Delta T$ for full-load operation was projected at 0.4 C over 1998 survey temperatures, and the average $\Delta T$ for Farrar Gut was 1.1 C. On the basis of these values, as well as monthly full-load projections, I concluded that:

1. Full-load temperature increases in the mainstem James River would not restrict the ability of any James River resident or anadromous fish species to find suitable habitats to meet its life cycle needs for reproduction, migration, growth, or survival.

2. Temperature increases in Farrar Gut could affect the duration of the annual attraction (winter)/avoidance (summer) schedule. However, such changes would be so slight as to be beyond detection.

3. Frequency of fish kills in Farrar Gut would not increase due to full-load operation.

Given that the new Hydroqual full-load $\Delta T$ projections are virtually identical to those in its earlier draft, I find no grounds for revising the conclusions summarized above.

John J. Ney

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**Assessment of the Thermal Impacts of Full Load Operation of Chesterfield Power Plant on the Fish Assemblage of the Lower James River**

by John J. Ney, Ph.D.
March 2002

Introduction

I have read the final draft of the Hydroqual report, "Thermal Modeling of the Chesterfield Power Station on the James River and Farrar Gut, Virginia" (Blumberg and Ahsan 2002) which predicts the temperature increases (ΔTs) that would occur in the receiving waters if Chesterfield Power Station (CPS) was operated at 100% loading (heat rejection of $5.5 \times 10^9$ BTU heat rejection) throughout the year. The following is my assessment of the response of the James River fish assemblage to those temperature increases. This analysis is based on my experience with the fish assemblage in the vicinity of CPS and its response to cooling water discharge. I was the primary author of the "Juvenile and Adult Fishes" section of the CPS 316(a) demonstration (Virginia Power 2000) and authored a 1996 report, "Analysis of the Incidence of Fish Mortalities in the Vicinity of the Chesterfield Power Station".

Hydroqual used the ECOM 3-dimensional, multi-grad model to predict temperature increases for 8 dates (3 winter, 1 spring, 4 summer) during 1998 at four stations in Farrar Gut (FG 1-4) and four stations in the James River. These dates were chosen to correspond to thermal surveys conducted for the 316(a) demonstration so that the model could be calibrated, and the predicted temperatures at 100% load could be compared to observed temperatures. The eight dates selected were times when CPS was operating at >75% load, so that worst-case conditions (i.e., high temperatures) could be examined.

The modeling effort appears to have been quite thorough, incorporating all relevant meteorological and hydrological variables, and its grid system provides fine-scale detail. Model validation was impressive, predictions agreeing with observations within ~1 C. Therefore, I have confidence in the model output and base my assessment on the temperature increases it predicts.

Response of the Fish Assemblage

The average predicted increase in ΔT for full loading in the James River is ~0.4 C over the surveyed temperatures on the 1998 dates. Temperature increases of this magnitude will not restrict the ability of any resident or anadromous James River fish species to find suitable habitat to meet its life cycle needs – reproduction, migration, growth, and survival. Temperatures in the mainstem James River increase so little that they do not merit further consideration

For Farrar Gut stations, the average predicted increase in $\Delta T$ based on the 1998 data is 1.1 C. While such increases are small, they have the potential to affect the annual attraction/avoidance cycle and the incidence of fish kills. I address both types of thermal response below.

Attraction/Avoidance

Most James River fishes prefer water temperatures of 25-32 C and have upper thermal tolerance limits of 36-40 C (Brown 1974; Houston 1982; Stefan et al. 1992). Fishes in this warmwater species complex (e.g., catfishes, largemouth bass, bluegill sunfish, gizzard shad) generally avoid waters >35 C, as was the case during 1997-99 summer surveys in Farrar Gut. The 316(a) demonstration also showed that the upper half of Farrar Gut provided a winter thermal refuge for several species, notably gizzard and threadfin shad and bluegill sunfish. Conversely, fish of all species avoided upper Farrar Gut (stations FG1 and FG2, sometimes extending to FG3) during the heat of summer (July surveys).

At full load, the Hydroqual model predicts winter water temperature increases of ~ 1 c at Farrar Gut stations. Temperatures will still remain within the attraction range (15-25 c) at stations FG1-FG3. The full-load predictions for summer (July-August) show slightly greater $\Delta T$s, probably because of reduced rate of atmospheric dissipation, averaging 2.1, 2.2, 1.2, and 0.9 C at stations FG1, FG2, FG3, and FG4, respectively. Summer water temperatures at FG1 and FG2 commonly exceed 40 C under present operating conditions, and fish avoid the area. They will continue to do so under full load. Summer temperatures at FG3 are frequently in the avoidance range (36+ C) under current operating conditions. The frequency of summer avoidance temperatures at FG3 may increase slightly if CPS is operated continuously at full load. However, summer avoidance temperatures should not occur at FG4 under 100% loading.

In summary, full load operation of CPS during winter should not attract more fish to upper Farrar Gut. Continuous 100% loading could, however, prolong the period of attraction a few days, depending on the temperature differential between the ambient James River and Farrar Gut. Similarly, fish will continue to avoid upper Farrar Gut during the peak summer months, with the duration of avoidance possibly prolonged a few days and extending to FG3 a bit more often than presently occurs. These potential temporal and spatial increases in the attraction/avoidance cycle are very slight; it would probably require several years of intense monitoring to quantify them, given inherent meteorological variability. They should have no discernable effects on the well-being of the James River fish assemblage.

Potential for Fish Kills

Fish kills have occasionally occurred in Farrar Gut. Three documented kills occurred during the late 1980s, most likely the result of malfunctions in the CPS chlorination system. (Ney 1996). In response, the chlorination system was replaced; no subsequent fish mortalities attributable to chlorine exposure have been observed.

However, a prolonged die-off, involving mostly gizzard shad, occurred during the winter of 1996, and a kill of threadfin shad happened in February 1999. Threadfin shad died when ambient James River temperature dropped below 7 C. The 1996 gizzard shad die-off was most probably due to repeated exposure to rapidly alternating water temperatures. In this extremely cold and snowy winter, the James River ambient water temperature dropped to as low as 3 C, which can be lethal to gizzard shad (Williamson and Nelson 1985). However, upper Farrar Gut temperatures were in the range of 16-21C. At high water slack tide, the very cold James River water pushed up the Gut, resulting in temperature drops of as much as 10 C within 1-2 hours. Gizzard shad can tolerate instant temperature drops of as much as 13 C (Cox and Coutant 1976), but the stress of repeated exposures (twice daily) to these shifts probably induced mortality.

Threadfin shad will continue to experience die-offs in the James River during cold winters. This species, native to the far southern U.S. and Mexico, has migrated northward as the climate has warmed, but it simply cannot tolerate cold winters. Of more concern is the potential for increased cold shock kills to gizzard shad such as occurred in 1996 if CPS is operated at full load. To the degree that discharge temperature increases, the temperature differential between it and incoming high-tide James River water will be greater. The Hydroqual model predicts an increase of ~ 1 C in the upper Gut, which, for the three 1998 winter dates examined, translated to a maximim of 21 C, which also occurred in upper Farrar Gut during the 1996 die-off period. During that extreme winter, high water slack temperature in Farrar Gut (measured by DEQ) dropped to as low as 11 C, resulting in a 10 C differential within 1-2 hours. The maximum differential would continue or be slightly increased (to perhaps 11 C) at full loading. As noted above, gizzard shad can tolerate this amount of cold shock, although probably not repeated exposure to it. The incidence of such multiple-exposure, cold-shock kills is the direct result of abnormally severe winters and can be expected to occur infrequently. Operation of CPS at full load should not increase the frequency of such kills.

With the exception of the 1999 threadfin shad event, all documented fish kills in Farrar Gut consisted predominantly of gizzard shad. As I noted in the 316(a) demonstration, the gizzard shad is one of the most abundant fishes in the lower James River and its population is refractory to localized die-offs.

<u>Conclusion</u>

Because the water temperature increases projected to result from full load operation of CPS are so slight, any effects on the attraction/avoidance cycle and frequency of fish kills in Farrar Gut would likely be so small as to be beyond detection, given the variable influences of hydrology and meteorology. In my opinion, full load operation of CPS, as projected by the Hydroqual model, will have no additional impact on the abundance and composition of the James River Fish assemblage.

## References

Blumberg, A.F., and Q. Ahsan. 2002. Thermal modeling of Chesterfield Power Station on the James River and Farrar Gut, Virginia. Hydroqual, Inc. report to Dominion Generation, Richmond.

Brown, H. 1974. Handbook of the effects of temperature on some North American fishes. American Electric Power Service Corporation, Canton, Ohio.

Cox, D.K., and C.C. Coutant. 1976. Acute cold-shock resistance of gizzard shad. Pages 159-161 *in* G.W. Esch and R.W. McFarlane, editors. Thermal Ecology II. U.S. Deparatment of Energy, Washington, D.C.

Houston, A.H. 1982. Thermal effects upon fishes. National research Council of Canada, Ottawa.

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Stefan, H.G., and 3 others. 1992. A methodology to estimate global climate change impacts on lake and stream environmental conditions and fishery resources with application to Minnesota. U.S. Environmental Protection Agency, Washington, D.C.

Virginia Power Company. 2000. Section 316(a) demonstration. VPDES Permit Number 0004146. Chesterfield Power Station.

Williamson, K.L., and P.C. Nelson. 1985. Habitat index suitability models and instream flow suitability curves: gizzard shad. U.S. Fish and wildlife service Biological Report 82 (10.112).

**Prepared and Submitted by:**

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Assessment of the Thermal Impacts of Full-Load Operation of the Chesterfield Power Plant on Biological Organisms and Fish Assemblages of the James River and Farrar Gut, Virginia

Comments on Revised Assessment HydroQual Report

By:

Cynthia M. Jones, Ph.D.
Director, Center for Quantitative Fisheries Ecology
Old Dominion University
4608 Hampton Blvd.
Norfolk, VA 23529

August 2003

<u>Summary Conclusions</u>

I have read the revised report from HydroQual dated April 25, 2003 (DRS10020) based on corrected flows (Unit 6 now modeled with 403 MGD) and various letters (April 9, 2003) attesting to mis-assumptions in the modeling effort that had previously assumed that the Chesterfield Power Generating Station (CPS) could operate at 100% without the water pumps all operating at 100%. In the revised evaluation, average temperature maxima are now 1.1°C in Farrar Gut and 0.6°C in the James River.

My evaluation is based on the original final draft (DRS 10010) of HydroQual dated February 19, 2002, revised report dated July 8, 2002, and the revised report (DRS 10020) dated April 25, 2003, and summary letters. HydroQual, Inc. performed full-load modeling with the ECOM three-dimensional hydrothermal model developed by Blumberg and Mellor (1980 and 1987). This model has been used successfully to model hydrodynamic systems throughout the U.S. To simulate full-load operation, the model was validated for on-site conditions at the CPS with data obtained from the environmental studies conducted from January through December 1998 from the Dominion Power monitoring survey (May 1997 through February 1999). These data were supplemented by HydroQual with other input data, such as wind speed and direction, and air temperature. The model was validated by simulating conditions during the survey period and noting that model output mirrored the on-site conditions then. Hence, the model could be used for subsequent simulations of full-load conditions. The model used a variable grid structure horizontally with a smaller grid size in critical areas such as Farrar Gut for finer detailed analysis of temperature conditions there. In Figures 14 and 15, the model simulation slightly overestimated summer temperatures at station FG4 and it could be argued that if the simulations for full load did the same, then the temperatures predicted by the model in the summer were a worst-case scenario. Even so, temperatures in Farrar Gut under full-load conditions increased, on average, only 1.1°C at FG4 and by 0.6 °C in the James River. These temperatures are slightly elevated over those observed in the field during the monitoring survey and are minor compared to the natural-environmental variability seen at the CPS sites observed under normal operating conditions.

The specific effects of increased temperature on fish assemblages were addressed previously by Dr. John Ney in his evaluation letter dated March 2002. The temperature in Farrar Gut has remained the same in this new set of model simulations and the ramifications of temperature increase to fish populations remain the same as in the last report. The only change in the model output is in the James River. Temperatures have increased by 0.2 °C in the new simulations. The fish assemblages in this area are mobile and the slight increase should not restrict their ability to survive or reproduce.

These new model results do not change my opinion that full-load operation of the CPS, as simulated by the HydroQual model, will have no additional impact on the biota of Farrar Gut and the lower James River.

Reference

Blumberg, A.F. and G.L. Mellor. 1980. A Coastal Ocean Numerical Model. *In* Mathematical Modeling for Estuarine Physics. Proceedings of an International Symposium, [Eds] J. Sundermann and K.P. Holz, Springer-Verlag, p 202-219.

Blumberg, A.F. and G.L. Mellor. 1987. A Description of a Three-Dimensional Coastal Ocean Circulation Model. Three-dimensional coastal ocean models, N.S. Heaps, ed., American Geophysical Union, Washington, D.C., 1-16.

## Jenkins,Ray

**From:** Kenneth_Roller@dom.com
**Sent:** Tuesday, November 18, 2003 10:47 AM
**To:** Jenkins,Ray
**Subject:** Re: Dr. Jones' August 2003 Biological Opinion

Ray-

Here are Dr. Jones' responses that we received back in early October. I thought that I had forwarded this information to you then, but can't find any record that I did. Sorry. Let me know if this is not adequate for the record.

I have received the final thermal modeling report from HydroQual, and should receive results of Dr. Lung's ammonia modeling tomorrow. I expect to officially submit both documents to you very soon.

Ken

----- Forwarded by Kenneth Roller/IN/FH/VANCPOWER on 11/18/03 10:39 AM
-----

Bill.Bolin
To: Kenneth Roller/IN/FH/VANCPOWER@VANCPOWER
10/09/03 12:22 PM cc: cjones@odu.edu
Subject: Re: Dr. Jones' August 2003 Biological Opinion

Pls find below Dr. Jones' answers to the latest questions from Ray. Pls advise me if this clarifies those outstanding questions. Thx, bill
----- Forwarded by Bill Bolin/LR/FH/VANCPOWER on 10/09/03 12:20 PM -----

"Cynthia Jones"
<cjones@odu.edu> To: Bill_Bolin@dom.com
cc:
10/08/03 06:10 PM Subject: Re: Dr. Jones' August 2003 Biological Opinion

Dear Mr. Bolin,

What I meant to say was that the average temperature increase in Farrar Gut was 1.1oC.

When I said "The only change in the model output is in the James River. Temperatures have increased by 0.2oC in the new simulations", I was indicating that there was an additional 0.2oC increase above the initial increase reported in the original simulations. This gave me no cause for concern.

Sincerely,

Cynthia

"How inappropriate to call this planet Earth when clearly it is Ocean"
Arthur C. Clarke, Nature 1990 attributed

Cynthia M. Jones, Ph.D.
Eminent Scholar and Professor
Center for Quantitative Fisheries Ecology
Old Dominion University
Phone: 757-683-4497
FAX: 757-683-5293

**Attachment 8**

Evaluation of Ground Water Monitoring Data

Attachment 8
Ground Water Evaluation
8/20/2012

In accordance with the Ground Water Monitoring Plan (GWMP) dated September, 2001, ground water monitoring is performed around three ponds on the Chesterfield site- the metals treatment pond, the “old” ash pond and the “new” ash pond.  See Attachment 1 for the overall layout of the ponds, Attachment 8.a for maps showing the location of the monitoring wells and Attachment 8.b for the approved monitoring plan.

Evaluation of Old Ash Pond monitoring results for the 2004 permit reissuance identified apparent increases in ground water concentrations of iron, ammonia, molybdenum, and zinc.  Suspected ground water quality impacts were also indicated for arsenic, barium, manganese, and vanadium.  Consequently, the 2004 permit called for a Corrective Action Plan.  Phase I of a Groundwater Quality and Risk Assessment Report was initially submitted February 2007 and subsequently revised in March of 2012.  The report included an evaluation of background monitoring well appropriateness.  The evaluation determined that neither B50 nor B51 are appropriate background wells.  Only B52 remains an appropriate background well, so statistical evaluations were performed to compare downgradient wells to B52.  The following parameters showed Statistically Significant Increases (SSIs) over background concentrations: dissolved arsenic, dissolved barium, dissolved cadmium, dissolved copper, dissolved iron, dissolved manganese, dissolved molybdenum, ammonia, and chloride.  A risk analysis was performed and is explained in detail in Attachment 8.d.  The Risk Assessment indicates that a complete pathway does not exist for groundwater receptors and that although surface water provides complete pathways for both human and ecological receptors, the GW contamination does not currently pose a risk to the receptors.  In order to address future risks, the 2013 permit reissuance includes a requirement for submittal of Phase II of the Groundwater Quality and Risk Assessment Report within 180 days of the effective date of the reissued permit.  Dominion proposes to establish groundwater action levels in a manner similar to the approach used for the New Ash Pond.  Action levels will be established for identified contaminants in the Revised Groundwater Quality and Risk Assessment Report.  Phase II will also include specific actions to be taken by the permittee if the proposed action levels are exceeded.

The basis for the monitoring program around the new ash pond (also referred to as the Upper (East) Ash Pond) was developed in 1984, approximately when the pond was constructed.  If contamination is detected in an initial set of downgradient wells, a second set of perimeter wells is to be constructed.  If contaminant levels exceed action levels specifically established for this site in the perimeter wells, corrective action is required.  See Attachment 8.b. for a detailed description of this program.  Attachment 8.c is the second quarter 2012 monitoring report submitted by Virginia Power. That report indicated that monitoring around the new ash pond has entered the “extended” phase.  Groundwater concentrations have not exceeded the Action Levels listed in the GWMP, but Dominion will continue to monitor at the New Ash Pond in the extended monitoring phase program and respond accordingly.  The above noted determination regarding background wells will impact future evaluations of ground water data at the new ash pond.

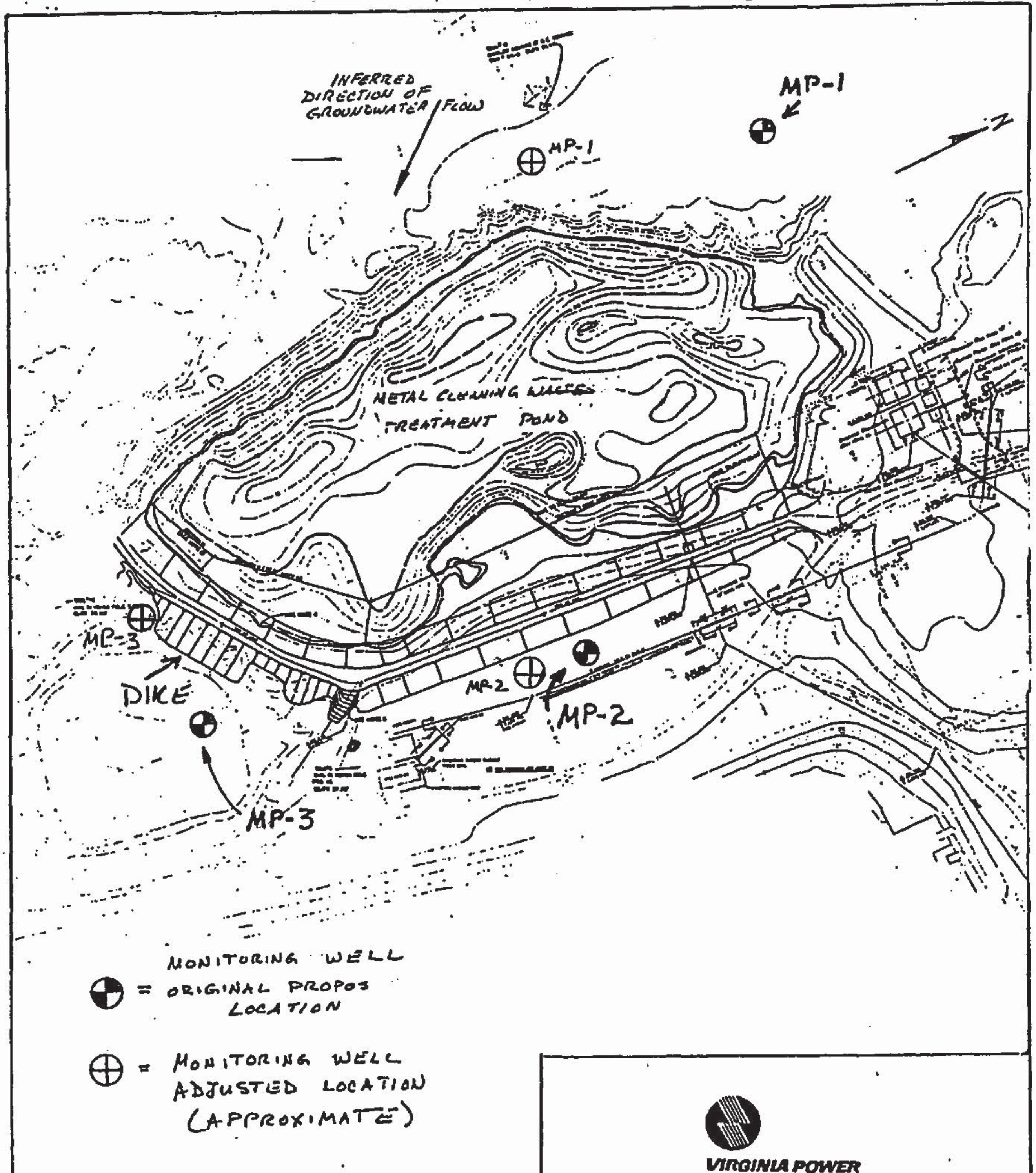
The Metals Pond monitoring data was evaluated statistically for increases over background concentrations.  The data was first evaluated for normality with the Shapiro-Wilks normality test.  Nonnormal data was then evaluated with the Wilcoxon Rank-Sum test, while normal data was evaluated with the student’s T-test.  The data sets for all parameters were found to be nonnormal and evaluated with Wilcoxon Rank-Sum test.  All parameters with the exception of chloride exhibited no statistically significant increase over background concentrations in downgradient wells. The data showed statistically significant increases in chloride over background concentrations in downgradient wells MP-1 and MP-3. Strongly correlated increasing trends were observed in downgradient wells, MP-2 and MP-3, and one hundred percent of the samples collected from MP-3 exceeded GW criteria for chloride. Chloride was added to the monitoring list for wells MP-1, MP-2, and MP-3 as a result of discharge of flue gas desulfurization purge water into the Metals Pond between 2008 and 2009. The chloride purge water was completely drained from the metals pond on March 20, 2009. Since 2009, a strong increasing trend has been observed in downgradient well MP-3. Consequently, a Corrective Action Plan is needed to address apparent increases in ground water chloride concentrations downgradient of the Metals Pond. See Attachment 8.e for the analysis.

**Attachment 8.a.**

Additional Detail - Proposed Well Locations


WWT
09/14/01

ATTACHMENT 1




VIRGINIA POWER

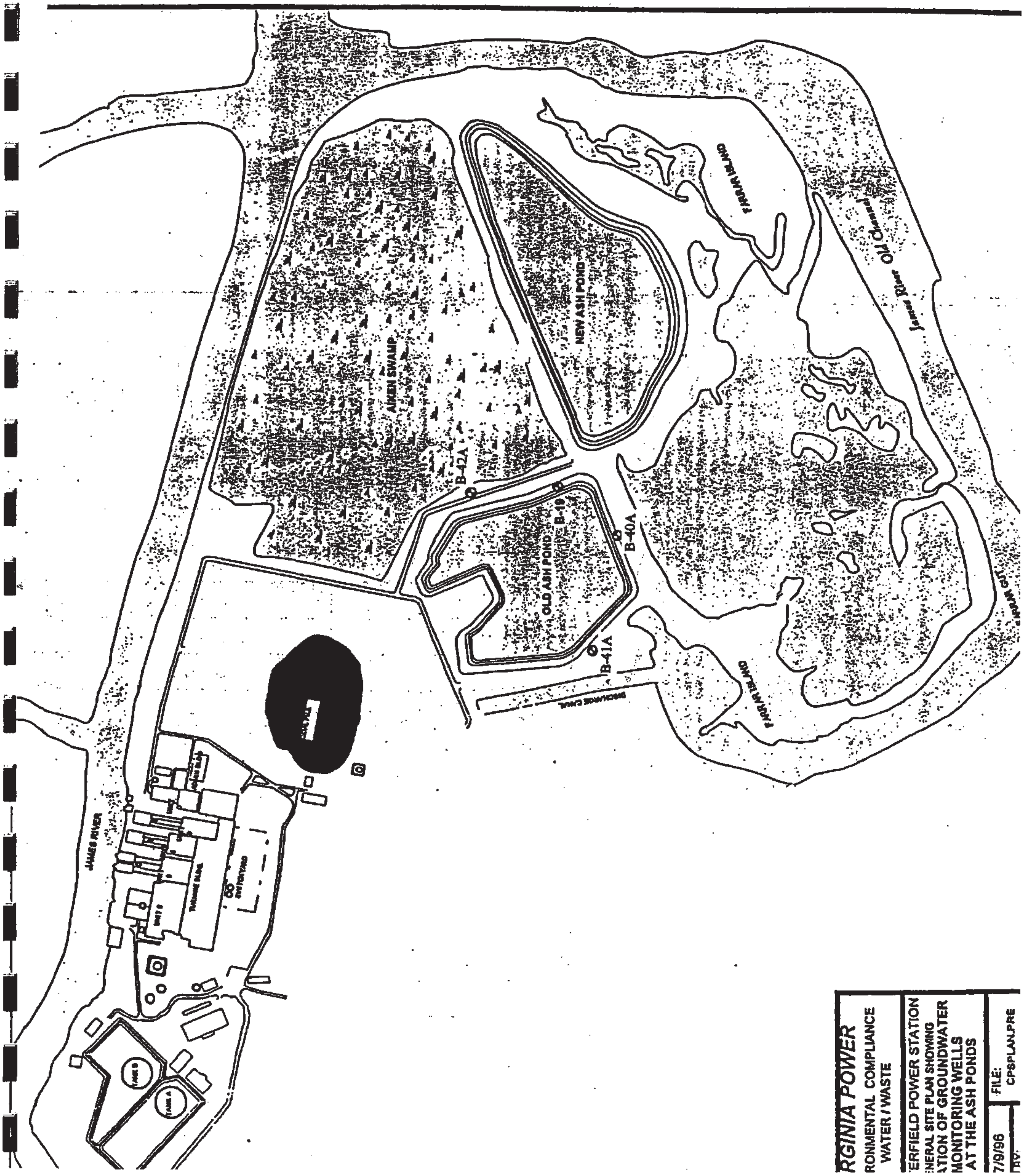
CHESTERFIELD POWER STATION
METAL CLEANING WASTES TREATMENT POND
MONITORING WELL LAYOUT
DATE: 5/12/87 BY: MS

Actual well locations may vary based on site conditions at time of installation.

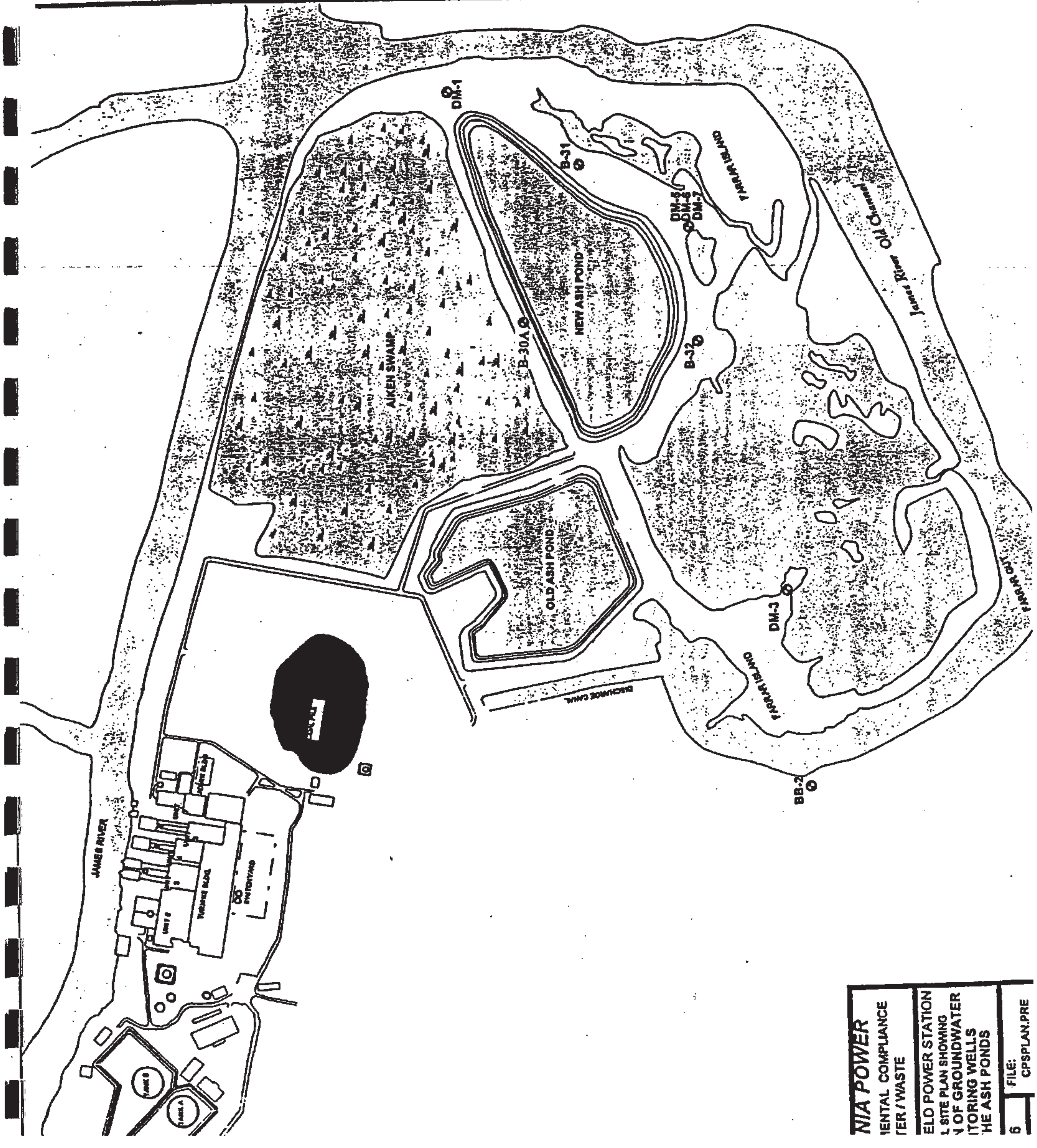
This sketch to accompany the Groundwater Monitoring Plan for Metal Cleaning Wastes Treatment Pond required by the Chesterfield Power Station VPDES Permit VA0004146.

Figure Appendix A-1

Old Ash Pond Monitoring Well Network



New Ash Pond Monitoring Well Network



Attachment 8.b.

## I. GENERAL

The purpose of this plan is to describe the methods and procedures for identifying and evaluating possible impacts to the groundwater from the Dominion Generation (Dominion) Chesterfield Power Station Ash Ponds and Metals Treatment Pond. The monitoring plans for the Old Ash Pond and the Metals Treatment Pond are included in Appendices A and B. Groundwater monitoring associated with Bulk Oil Storage at the facility is conducted under the station's Oil Discharge Contingency Plan program (FC-043539).

The evaluation for the New Ash Pond will include statistical and qualitative analyses of the groundwater monitoring data from the New Ash Pond monitoring well network. The plan also identifies actions to be taken pending the outcome of statistical and qualitative analyses. The monitoring well locations for the New Ash Pond are shown on Figure 1.

In general, the groundwater monitoring at the New Ash Pond is divided into three phases: detection monitoring, extended monitoring, and assessment monitoring. Advancement from one phase to the next is determined by statistical comparisons and trend analysis. The phases are described in the following sections of the plan.

A flow chart delineating the monitoring and action requirements is attached as Figure 2

## II. COMPARISONS WITH BACKGROUND

The nature of the previously used groundwater monitoring well network relative to the New Ash Pond is such that there are no true upgradient wells. In previous groundwater monitoring events, Dominion has used offsite wells to perform interwell comparisons. Dominion will provide for more representative interwell comparisons by utilizing upgradient wells in future monitoring events. Within 90 days of the approval of this plan, Dominion will install three wells in the uppermost aquifer in locations appropriate for upgradient use in the New Ash Pond monitoring program. A qualified groundwater scientist has determined the new upgradient well locations based on site topography, existing site conditions (e.g., coal stockpile location), and drill rig access (above and below ground obstructions). The proposed locations are included on Figure 1.

The new upgradient wells will be monitored and the data statistically analyzed on the same frequency as the perimeter wells to identify variations in groundwater not potentially affected by the New Ash Pond. The analysis of the new upgradient wells will assist Dominion in determining the extent to which the groundwater quality is affected naturally or by sources other than the New Ash Pond.

The wells are listed in Table 2.

## III. ESTABLISHING BACKGROUND CONCENTRATIONS

Upon completion of the installation of new upgradient wells, Dominion will collect background data from the new wells over a period of four quarters. Following background data collection, Dominion will initiate statistical analyses. For subsequent interwell comparisons, the background data set will consist of all data from the upgradient wells through the event prior to the event being analyzed.

Dominion may adjust or modify the establishment of the background for statistical comparisons, as well as the statistical methodology for evaluating groundwater quality, if it can demonstrate to the Virginia Department of Environmental Quality (VDEQ) that the modifications or adjustments are necessary to provide a more accurate and statistically valid evaluation of impact.

## IV. PHASES OF MONITORING

The monitoring will consist of three separate phases: 1) detection monitoring where a short list of parameters is monitored quarterly and the extended list monitored annually; 2) extended monitoring where the groundwater is monitored quarterly for the extended list of parameters; and 3) the assessment phase where additional perimeter wells are installed and monitored quarterly for the extended list of parameters.

In each phase the data will be analyzed statistically to identify significant differences over background (interwell) using the methods described in subsequent sections of this plan.

### IV.A Detection Monitoring Phase

The detection monitoring phase consists of quarterly monitoring for the parameters designated in Table 1 as detection parameters, and the associated statistical analysis for significant differences over background.

The groundwater quality data for the perimeter wells will be compared with the upgradient well background data in an interwell analysis to identify potential problems. The interwell analysis will compare the current period data for each perimeter well to the upper prediction limit (UPL) calculated using the pooled data from the upgradient wells through the event prior to the one being evaluated.

Additional types of analyses may be performed annually during the detection monitoring phase to augment the interwell analyses for the annual impact evaluation report. The results of the statistical analyses will be used to prepare an annual report of groundwater quality at the ash ponds.

If an individual detection parameter exceeds the UPL in the interwell analyses for two consecutive quarters in the same perimeter well, then the monitoring will move to the extended phase.

### IV.B Extended Monitoring Phase

The extended monitoring phase consists of quarterly monitoring for the entire list of parameters in Table 1, the associated statistical analyses for significant differences over background, and trend analysis. The quarterly monitoring for the extended parameter list will continue for at least four quarters.

If an individual parameter does not exceed the UPL in the interwell analysis for four consecutive quarters in the same perimeter well, or if it can be demonstrated that UPL exceedences are seasonal in nature or below the practicable quantitation limit (PQL), Dominion may return to the detection monitoring phase. Dominion will continue quarterly monitoring of the entire list of parameters until meeting either the above conditions for returning to detection monitoring or the following conditions for proceeding to assessment monitoring.

If an individual parameter exceeds the UPL in the interwell analysis for four consecutive quarters on data above the PQL that is not seasonal in nature in the same perimeter well, additional monitoring will be performed in order to provide trend analysis. If, after at least eight quarters of the additional monitoring, a statistically significant trend is identified for an action level parameter in the same perimeter well using an appropriate statistical method on data above the PQL, Dominion will submit to the VDEQ a plan to extend the monitoring well network beyond the current perimeter. Once that plan is approved and the wells installed, the next phase, assessment monitoring, will commence.

### IV.C Assessment Monitoring Phase

The assessment monitoring phase consists of monitoring the extended well network quarterly for the entire list of parameters. If an individual action level is exceeded for three consecutive quarters in the same perimeter well Dominion will notify the VDEQ and, within 90 days, will provide to the VDEQ a detailed plan and schedule for corrective action.

## V. DATA ANALYSIS

### V.A. Interwell Analysis

The interwell analysis during detection monitoring consists of comparing the current data with the pooled historical data. This is done by pooling the data from all of the upgradient wells for the period through the event prior to the one being evaluated and calculating the UPL. The UPL is calculated using a sitewide error rate of 0.05 with adjustments for the number of comparisons in the analysis. The current monitoring data are then compared to the UPL. Values greater than the UPL are considered to be a significant difference in concentration from the background data. The methodology for these types of comparisons is found in "Statistical Methods for Groundwater Monitoring," by R. D. Gibbons, John Wiley & Sons, 1994. The methodology is similar to the EPA's Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance, Draft, Office of Solid Waste, July 1992.

### V.B Trend Analysis

Trend analysis of concentrations in individual wells is useful in evaluating groundwater quality where there has been previous impact. Generally, statistical methods such as regression analysis or the Shewart-Cusum control chart method will be used in conjunction with a qualitative method such as a time plot of the data. Because of the degree of analytical variability below the PQL, the trend analyses will be performed only for those wells and parameters where the measured values are equal to or greater than the PQL. The Dominion PQLS, listed in Table 1, are below the action level values; therefore, the trend analysis will be able to identify quantifiable trends before they reach an action level.

## VI. ACTION LEVELS

The action levels listed in Table 1 were developed by Dames & Moore for the original groundwater monitoring plan (August 10, 1984). The methodology used by Dames and Moore is included in Appendix C.

## VII. REPORTING

Quarterly reports will be submitted to the VDEQ on the following annual schedule:

First quarter report by April 10
Second quarter report by July 10
Third quarter report by October 10
Fourth quarter report by January 10

Annual report by March 31

The quarterly reports will include a synopsis of the statistical analyses and will note any statistically significant differences and, when applicable, trends identified by the analyses.

The annual report will evaluate the groundwater quality at the site.

**Table 1**
**New Ash Pond Groundwater Monitoring Parameters**

| Parameter | Action Level | PQL SW-846 | Detection Phase Frequency | Type of Parameter |
|---|---|---|---|---|
| Groundwater Elevation | NA | NA | Quarterly | Detection |
| Ammonia | NA | NA | Quarterly | Detection |
| Copper | 2,000 µg/l | 10 µg/l | Quarterly | Detection |
| Chloride | NA | NA | Quarterly | Detection |
| Conductivity | NA | NA | Quarterly | Detection |
| Molybdenum | 200 µg/l | 5.0 µg/l | Quarterly | Detection |
| Nitrate | NA | 50.0 µg/l | Quarterly | Detection |
| Iron | NA | 250.0 µg/l | Quarterly | Detection |
| pH | NA | NA | Quarterly | Detection |
| Sulfate | NA | 300.0 µg/l | Quarterly | Detection |
| Total Dissolved Solids (TDS) | NA | NA | Quarterly | Detection |
| Total Hardness | NA | NA | Quarterly | Detection |
| Zinc | 10,000 µg/l | 0.5 µg/l | Quarterly | Detection |
| Arsenic | 100 µg/l | 10.0 µg/l | Annually | Extended |
| Barium | 2,000 µg/l | 15 µg/l | Annually | Extended |
| Cadmium | 20 µg/l | 1.0 µg/l | Annually | Extended |
| Chromium | 100 µg/l | 10 µg/l | Annually | Extended |
| Chromium (hexavalent) | NA | 25 µg/l | Annually | Extended |
| Lead | 100 µg/l | 10.0 µg/l | Annually | Extended |
| Manganese | NA | 100.0 µg/l | Annually | Extended |
| Mercury | 4 µg/l | 1.0 µg/l | Annually | Extended |
| Selenium | 20 µg/l | 10 µg/l | Annually | Extended |
| Silver | 10.8 µg/l | 10 µg/l | Annually | Extended |
| Vanadium | 200 µg/l | 110 µg/l | Annually | Extended |

Dissolved metals will be reported

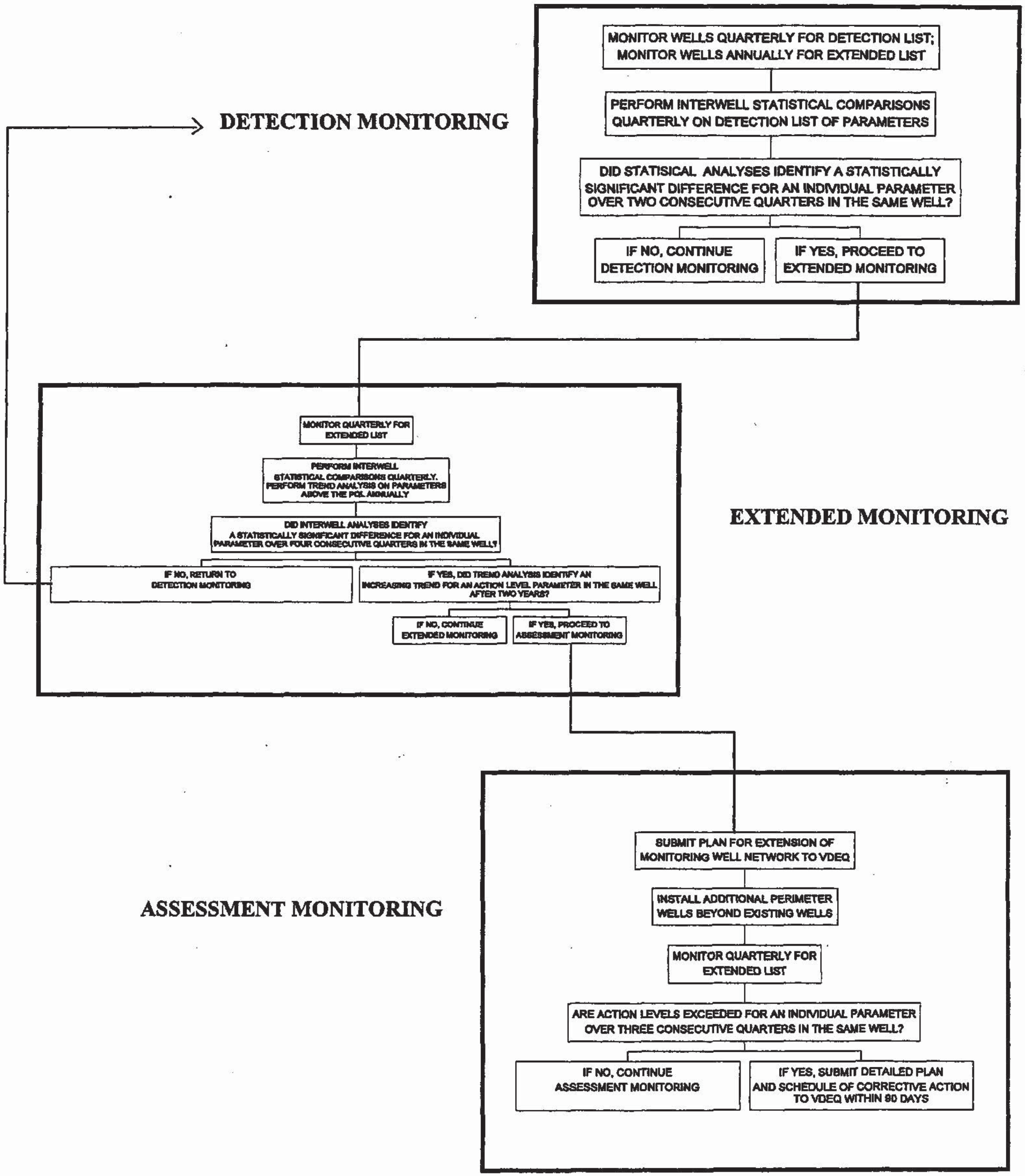
**Table 2**

**New Ash Pond
Monitoring Wells**

| Perimeter Wells | Upgradient Wells |
|---|---|
| B-30A | B-50 |
| B-31 | B-51 |
| B32 | B-52 |
| DM-1 | |
| DM-5 | |
| DM-6 | |
| DM-7 | |

## *CHESTERFIELD POWER STATION GROUNDWATER MONITORING PLAN - FIGURE 2*

*ASH PONDS GROUNDWATER MONITORING FLOW CHART*



## APPENDIX C

**Includes:**
**Appendices A & B**
**(re: action levels)**
**from Dames & Moore report**
**dated August 10, 1984**

## APPENDIX A
## METHODOLOGY FOR DEVELOPMENT OF ACTION LEVELS

Action levels (concentrations not to be exceeded at the site boundary shown in Figure 1) are proposed for toxic metals leached from the ash impoundments. If exceeded, implementation of the proposed corrective action will be required. Factors that must be considered in developing action levels include background water quality (as previously discussed); existence of current exceedances of water quality or action level standards; lateral and vertical distance from potential sources of contamination (ponds); attenuative capacity of subsurface environment, surface water, and other geochemical conditions; site specific hydrologic regime; and future beneficial uses of groundwater underlying the site.

Previously completed studies and available data have provided site specific information on the pattern of groundwater movement and its relationship to the surface water regime. These indicate that the most appropriate locations for setting action levels will be at the site boundaries, where the main component (horizontal) of flow discharges to surface water, and to a lesser degree in the deep wells, as an indicator of limited potential for vertical migration to the deeper aquifers. This approach recognizes that attenuative capacities of subsurface materials and dilution in the aquifer will reduce concentrations of contaminants migrating away from the ponds before they enter surface water.

Given the existing poor quality of shallow groundwater underlying the site and the industrial nature of the surrounding area, we anticipate that no drinking water supplies will be developed here in the future and that expected future beneficial uses of this resource would most likely be limited to some industrial uses. Therefore, we propose that action levels for potential ash contaminants not be limited to EPA's Interim Primary and Proposed Secondary Drinking Water Standards (IPDWS).

As a guideline to setting action levels, a "worst case" contamination scenario was developed for this site by Dr. D.I. Siegel, a specialist in natural water geochemistry. His work is included in Appendix B, and provides a rationale for selecting the action levels. Based on presently available data and worst case conditions, we propose that action levels in the shallow aquifer at the property boundary be set at the levels shown in Table A-1. We also propose that action

TABLE A-1

Action Levels at Site Boundary[a]

Chesterfield Power Station Impoundments

| Parameter | Action Level[b] (mg/l) |
|---|---|
| Arsenic | 0.1 |
| Barium | 2.0 |
| Cadmium | 0.02 |
| Chromium, Total | 0.1 |
| Copper | 2.0 |
| Lead | 0.1 |
| Mercury | 0.004 |
| Molybdenum | 0.2 |
| Selenium | 0.02 |
| Silver | 0.1 |
| Vanadium | 0.2 |
| Zinc | 10 |

[a]See Figure 1 for location of site boundary.

[b]For parameters whose background standard exceeds the listed action level, exceedances of the background standard instead of the specified action level will result in implementation of corrective action.

levels in the deep wells be set at these same levels. This would be consistent with other action levels, since available data indicate that this groundwater would not be used for human consumption and ultimately discharges to the river, and the "worst case" scenario indicates that these levels would provide adequate protection for surface water.

For those parameters shown to exceed proposed action levels in background data, action levels will be adjusted to that exceedance value so that further degradation does not occur. This will provide a conservative measure against contamination.

# APPENDIX B

# WORST CASE SCENARIO

## APPENDIX B
## WORST CASE SCENARIO

Action levels are evaluated using a "worst case" scenario. The scenario for the proposed ash impoundment includes evaluating the effect of maximum trace metal loading (the product of concentration and groundwater volume per unit time) from impoundment leachate to the James River at low flow when dilution of the trace metals would be least.

Maximum concentrations of trace metals leached from the impoundment to the groundwater will be controlled by the following:

1. Ion exchange capacity of clays for metals
2. Sorptive capacity of organics for metals
3. Effect of hydrologic events upon sorption/desorption of metals
4. Effect of hydrologic events on groundwater gradients.

Ion exchange refers to the exchange of a metal occupying a structural position in a clay mineral by another metal. The degree and order of exchange can be quantified by a chemical constant called the distribution coefficient (Kd), which is experimentally determined. Distribution coefficients for the metals of interest--As, Se, V, and Zn--have not been determined for mixed clay soils. Selectivity of a metal for exchange is closely related to the crystalline radius of the metal (Gast, 1977); metals with larger ionic radii are favored in the exchange process. Table B-1 shows that As, Se, V, and Zn would be less involved in ion exchange than Ca and Na, metals that are abundant in groundwater at the site. In fact, the Na-$HCO_3$ type groundwater at the site (Dames & Moore, 1983) clearly documents the existence of Ca-Na ion exchange as a major geochemical process in the system.

Since ion exchange at the study site is probably dominated by the exchange of Ca for Na, low concentrations of As, Se, V, and Zn in groundwater adjacent to the existing fly ash pond is probably caused by metal sorption and complexation to organic material in the surface materials. The sorptive capabilities of peat and organic material for trace metals is well known (e.g., Chaney and Hundemann, 1979), although little definitive experimental work has been done with the metals of interest. One set of experiments by Rashid (1974) involved passing water containing 10 mg/l of Co, Cu, Ni, and Zn through a column of peat, resulting in significant sorption (Table B-2). Although comparable data are not available for V,

Table B-1

Ionic Radii of Selected Metals

| Metal | Radii (angstroms) | Order of Selectivity in Possible Ion Exchange |
|---|---|---|
| Ca | 0.99 | 1 |
| Na | 0.95 | 1 |
| Zn | 0.79 | 2 |
| Mg | 0.65 | 3 |
| V | 0.65 | 3 |
| As | 0.58 | 4 |
| Se | 0.42 | 5 |

Table B-2

(From Rashid, 1974)

Sorption of Selected Trace Metals to Peat

| Metal | Sorption (mg/g) |
|---|---|
| Co | 9.6 |
| Cu | 67.4 |
| Ni | 17.4 |
| Zn | 26.1 |

Se, and As, it is probable that they are sorbed at a similar order of magnitude as these metals.

There is no estimate for the amount of organic material contained in the surficial materials north of the proposed impoundment site through which contaminants would pass, although the widespread wetlands indicate that there is a large source of organics available for sorbing trace metals. It is unlikely that the sorptive capacity of the surficial materials would be exceeded, given the relatively low volumes of leachate that could recharge the groundwater system from the proposed fly ash pond, which is underlain by clayey sediment with low vertical hydraulic conductivity. However, the pH of ground water at the study site is generally acidic (less than 7.0), in part because of organic acids contributed from the wetlands. Precipitation is even more acidic, because of acid rain (Munger and Eisenreich, 1983), and temporary desorption of metals from the organic material could occur during acidic recharge events.

Finally, variations in potential chemical loading to the James River from the impoundment is both controlled by the amount of groundwater discharge, dependent upon the hydraulic gradient and hydraulic conductivity of the porous material, as well as the absolute concentrations of metals.

Evaluation of potential chemical loading to the James River is made difficult by the qualitative understanding of the processes enumerated above. A worst case scenario would involve desorption of metals from aquifer matrix during low flow conditions of the river. During low flow, dilution of the leachate would be least.

A rough calculation of maximum groundwater flux to the river can be done as follows. It is assumed that water in the proposed fly ash pond is at the top of the proposed perimeter dike (42 feet above mean sea level). The average distance from the pond to the Dutch Gap Cutoff Channel is about 2,500 feet. The elevation of the river is about 1 foot above sea level. The maximum gradient would be about:

$$I = \frac{(42 - 1)}{2,500} = 0.0164$$

Groundwater flux is calculated from Darcy's Law. Although vertical recharge to the regional groundwater system will be limited by the very low vertical hydraulic conductivity of the underlying sediments, it is assumed for this worst case analysis that recharge occurs to more permeable units in hydraulic communication with the river. The assumed lateral hydraulic conductivity of the affected aquifer is 0.0003 ft/s (0.01 cm/s), based on information contained in the Dames & Moore report (July 15, 1983). It is also assumed that the thickness of the aquifer is about 50 feet, twice the maximum thickness of layer 3 (Dames & Moore, 1983). The reach of Dutch Gap Cutoff receiving groundwater discharge from the pond is assumed to be 1 mile in length.

Darcy's Law is: $Q = KAI$

where: $Q$ = discharge

$K$ = hydraulic conductivity

$A$ = cross sectional area

$I$ = hydraulic gradient.

For this analysis:

$$Q = 0.0003 \times 50 \times 5{,}280 \times 0.0164 = 1.30 \text{ cubic feet per second.}$$

For this worst case analysis, it will be assumed that the maximum concentrations of trace metals found in the fly ash leachate are those concentrations found in the possible contaminant plume intersecting the river. Concentrations of metals desorbed during a recharge event would not likely exceed these concentrations. Should the sorptive capacity of the sediments be exceeded in time, the contaminants advected with groundwater would have these concentrations. This analysis ignores the mitigating effects of ion exchange and sorption. Dilution of the groundwater discharge by James River water can be modeled by the following equation:

$$Cd(Vr + Vg) = CrVr + CgVg$$

where: $Cd$ = concentration of metals in river water and groundwater mixture

$Cr$ = concentration of metals in river

$Cg$ = concentration of metals in groundwater

$Vr$ = instantaneous river discharge

$Vg$ = instantaneous groundwater discharge.

It is assumed for the worst case analysis that:

$Cg$ = 65 µg/l (maximum concentration in the pond leachate for selenium, which is 6.5 times the maximum concentration allowed in drinking water; no other fly ash contaminant exceeded its drinking water standard by as large a percentage as selenium, therefore, this analysis is very conservative for other fly ash contaminants)

Cr = 2 µg/l (detection limit of selenium in samples obtained from James River at Dutch Gap cutoff)

Vr = 700 cfs (about the 7-day, 10 year low flow of the James River near the site)

Vg = 1.3 cfs (calculated from Darcy's Law).

The calculation results in river water with a selenium concentration of about 2.1 µg/l, implying an increase of only 0.1 µg/l or 5 percent under worst-case conditions; i.e., conditions assuming maximum hydraulic gradients in the ash impoundment and historic low flow in the James River, using a contaminant concentration observed to have the largest exceedence over drinking water standards, and neglecting the effects of chemical attenuation or dilution in the subsurface environment. The concentration of 2.1 µg/l is still well below the drinking water standard for selenium, which is 10 µg/l.

Based on the worst-case analysis, it can be concluded that possible leachate from the impoundment will not significantly affect the water quality of the river during historic low flow conditions. Therefore, adverse impact on river water quality from fly ash tailings leachate during normal pond operating conditions and normal river flow conditions is highly unlikely. (This neglects chemical attenuation and dilution in the subsurface environment, which will serve to further reduce contaminant concentrations.) As an added safety factor against river water quality degradation and preservation of groundwater for future beneficial uses, an action level equal to less than one-third of the selenium concentration found to have insignificant effects on river water quality is proposed. That is, instead of setting the action level at the site boundary at 65 µg/l (which is highly unlikely to have an adverse impact on river water quality), the action level proposed for selenium is 20 µg/l, only twice the drinking water standard. Since other fly ash contaminants in the tailings ponds are expected to have even less impact on river water quality than selenium, this rationale can be conservatively used in determining action levels for these parameters. That is, action levels for all fly ash contaminants are proposed at twice their drinking water standard, as shown in Table A-1.

Table B-3 presents the results of worst-case analyses performed for all fly ash contaminants for which action levels have been proposed, to illustrate the

Table B-3

Worst-Case Analysis for Mixing of Leachate and River Water

| Parameter | Proposed Action Level | Measured River Concentration | Concentration of Leachate - River Mixture | Drinking Water Standard |
|---|---|---|---|---|
| Arsenic | 100 | 4 | 4.18 | 50 |
| Barium | 2,000 | 100 | 103.52 | 1,000 |
| Cadmium | 20 | <5 | 5.03 | 10 |
| Chromium | 100 | <10 | 10.17 | 50 |
| Copper | 2,000 | <20 | 23.67 | 1,000 |
| Lead | 100 | <100 | <100 | 50 |
| Mercury | 4 | <1 | 1.01 | 2 |
| Molybdenum | 200 | <100 | 100.19 | -- |
| Selenium | 20 | <2 | 2.03 | 10 |
| Silver | 100 | <10 | 10.17 | 50 |
| Vanadium | 200 | <200 | <200 | -- |
| Zinc | 10,000 | 60 | 78.43 | 5,000 |

Notes:

1. All concentrations are given in µg/l (ppb).
2. River water quality is determined from tests on samples collected 5-31-84, 6-14-84, and 6-26-84 at Vepco's oil dock and Farrar Gut.
3. Worst-case analysis assumes historic low flow in James River (700 cfs), and leachate flow based on maximum hydraulic gradient (1.3 cfs).

This page has been revised 12/7/84 (11/5/84) to show a silver action level of 10.8. Revised copy is attached to this sheet. WHS 6/20/88

Table B-3

Worst-Case Analysis for Mixing of Leachate and River Water

| Parameter | Proposed Action Level | Measured River Concentration | Concentration of Leachate - River Mixture | Drinking Water Standard |
|---|---|---|---|---|
| Arsenic | 100 | 4 | 4.18 | 50 |
| Barium | 2,000 | 100 | 103.52 | 1,000 |
| Cadmium | 20 | <5 | 5.03 | 10 |
| Chromium | 100 | <10 | 10.17 | 50 |
| Copper | 2,000 | <20 | 23.67 | 1,000 |
| Lead | 100 | <100 | <100 | 50 |
| Mercury | 4 | <1 | 1.01 | 2 |
| Molybdenum | 200 | <100 | 100.19 | -- |
| Selenium | 20 | <2 | 2.03 | 10 |
| Silver | 10.8 | <10 | 10.17 | 50 |
| Vanadium | 200 | <200 | <200 | -- |
| Zinc | 10,000 | 60 | 78.43 | 5,000 |

Notes:

1. All concentrations are given in µg/l (ppb).
2. River water quality is determined from tests on samples collected 5-31-84, 6-14-84, and 6-26-84 at Vepco's oil dock and Farrar Gut.
3. Worst-case analysis assumes historic low flow in James River (700 cfs), and leachate flow based on maximum hydraulic gradient (1.3 cfs).

insignificance of effects on river quality if contaminants at proposed action level concentrations enter the James River. The analyses are based on measured river water quality. Where contaminant concentrations less than the chemical testing detection limit were observed, the detection limit was used to represent river water quality for purposes of these calculations. In all cases except for lead, river water quality under worst-case conditions is substantially below drinking water standards after mixing with leachate. Since the action level for lead is equal to the detection limit, no increase in the assumed background river water quality is noted. Also, since the detection limit is twice the drinking water standard, future analyses for lead should use a detection limit smaller than 50 µg/l. Table B-3 illustrates that even under worst-case conditions, future beneficial uses of groundwater or surface water at the site will not be adversely affected.

**Attachment 8.c.**

**Dominion Resources Services, Inc.**
5000 Dominion Boulevard, Glen Allen, VA 23060
Web Address: www.dom.com

**Dominion**®

Piedmont Regional Office
JUL 09 2012
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July 5, 2012

Ms. Emilee Adamson
Virginia Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, VA 23060-6295

**Re: Chesterfield Power Station – 2012 Second Quarter Groundwater Monitoring Report VPDES Permit VA0004146**

Dear Ms. Carpenter:

Attached for your review are the second quarter 2012 groundwater monitoring results for the New Ash Pond, Old Ash Pond, and Metals Pond Facilities at the Chesterfield Power Station. This report contains a summary of analytical data for all three facilities and statistical analyses for the New Ash Pond.

Groundwater monitoring samples were collected on April 4, 2012. Tables 1, 2, and 3 summarize the laboratory analytical results for this latest sampling event for each facility. The New Ash Pond currently monitors under the extended monitoring phase, which includes an extended list of parameters, monitored quarterly.

Complete statistical analyses for detected parameters at the New Ash Pond were performed in accordance with EPA's March 2009 *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* and the Facility Groundwater Monitoring Plan (GMP; 2001). Results of these analyses are presented following the tables in the attachment to this letter. The inter-well analysis compares the data from each downgradient well to the upper prediction limit calculated from the background well data set and therefore identifies Statistically Significant Increases (SSIs) in downgradient wells over background.

Inter-well statistical analyses were performed on detected parameters in downgradient wells from the April 2012 sampling event against historical background well concentrations at the New Ash Pond. Table 4 summarizes the results of inter-well statistical analyses. These statistical analyses indicated SSIs for the following constituents:

- Iron, Dissolved in well B-30A (no action limit listed in the GMP);
- Ammonia in well B-30A (no action limit listed in the GMP); and
- Conductivity in well B-32 (no action limit listed in the GMP).

In accordance with the GMP, trend analyses are to be provided for those monitoring wells and parameters that have indicated four consecutive quarterly SSIs. Currently, there are no parameters with four consecutive SSIs. Please note groundwater concentrations did not exceeded the Action Levels listed in the GMP during this latest sampling event. Dominion will continue to monitor at the New Ash Pond in the extended monitoring phase program.

As indicated in previous quarterly monitoring reports, chloride was added to the monitoring list for monitoring wells MP-1R, MP-2, and MP-3 as a result of discharge of flue gas desulfurization purge water into the Metals Pond (see Table 3). The chloride purge water was completely drained from the Metals Pond on March 20, 2009.

The reported measurements were obtained by employing methods of analysis that are legally required, or otherwise appropriate to the monitoring objective, and are being reported in accordance with regulatory requirements. The reported measurements truly, accurately and completely represent the observed results of the monitoring required, but only the observed results. Those measurements are subject to the accuracy, precision, detection, and quantitation limitations associated with those methods in the subject sample matrices at the concentrations present in the sample. Any regulatory actions that may be taken based on these measurements must account for those limitations.

If you have any questions or comments regarding the enclosed information, please contact Jason Ericson of Dominion Electrical Environmental Services, at (804) 273-3485.

## Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

| | |
|---|---|
| Cathy C. Taylor | Director, Electric Environmental Services |
| Name of Authorized Agent | Title |
| Cathy C Taylor | 7/5/2012 |
| Signature of Authorized Agent | Date |

Attachment

**Table 1**
**Chesterfield Power Station - New Ash Pond**
**Groundwater Monitoring Well Report for April 4, 2012**

| | | | Downgradient Wells | | | | | | | Background Wells | | | Field QC | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter Name** | **LOD** | **LOQ** | **B-30A** | **B-31** | **B-32** | **DM-1** | **DM-5** | **DM-6** | **DM-7** | **B-50** | **B-51** | **B-52** | **DM-5 DUP** | **FIELD BLANK** |
| **Metals (mg/L)** | | | | | | | | | | | | | | |
| Arsenic, Dissolved | 0.003 | 0.010 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | **0.004** J | NS | <0.003 | <0.003 | <0.003 |
| Barium, Dissolved | 0.003 | 0.015 | **0.340** | **0.017** | **0.043** | **0.052** | **0.295** | **0.008** | **0.013** J | **0.345** | NS | **0.033** | **0.310** | <0.003 |
| Cadmium, Dissolved | 0.0003 | 0.0015 | <0.0003 | <0.0003 | <0.0003 | <0.0003 | <0.0003 | <0.0003 | <0.0003 | <0.0003 | NS | **0.0007** J | <0.0003 | <0.0003 |
| Chromium, Dissolved | 0.001 | 0.005 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | NS | <0.001 | <0.001 | <0.001 |
| Chromium (hexavalent) | 0.005 | 0.005 | <0.005 | <0.005 | <0.005 | **0.006** | <0.005 | <0.005 | <0.005 | <0.005 | NS | <0.005 | <0.005 | <0.005 |
| Copper, Dissolved | 0.001 | 0.005 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | NS | <0.001 | <0.001 | <0.001 |
| Iron, Dissolved | 0.05 | 0.25 | **21.23** | <0.05 | <0.05 | **2.19** | <0.05 | <0.05 | **0.06** J | **4.81** | NS | <0.05 | <0.05 | <0.05 |
| Lead, Dissolved | 0.001 | 0.005 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | NS | <0.001 | <0.001 | <0.001 |
| Manganese, Dissolved | 0.02 | 0.05 | **1.23** | **0.02** J | **1.91** | **0.27** | **0.48** | **0.03** J | **0.05** | **2.46** | NS | **0.02** J | **0.46** | <0.02 |
| Mercury, Dissolved | 0.0002 | 0.001 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | NS | <0.0002 | <0.0002 | <0.0002 |
| Molybdenum, Dissolved | 0.001 | 0.005 | <0.001 | <0.001 | <0.001 | **0.002** J | <0.001 | <0.001 | <0.001 | <0.001 | NS | <0.001 | <0.001 | <0.001 |
| Selenium, Dissolved | 0.003 | 0.010 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | NS | <0.003 | <0.003 | <0.003 |
| Silver, Dissolved | 0.0001 | 0.0004 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | NS | <0.0001 | <0.0001 | <0.0001 |
| Vanadium, Dissolved | 0.001 | 0.005 | <0.001 | <0.001 | <0.001 | **0.002** J | <0.001 | <0.001 | <0.001 | <0.001 | NS | <0.001 | <0.001 | <0.001 |
| Zinc, Dissolved | 0.01 | 0.03 | **0.018** J | **0.017** J | **0.020** J | **0.035** | **0.019** J | **0.017** J | **0.019** J | **0.019** J | NS | **0.027** J | **0.019** J | <0.01 |
| **Water Quality Parameters (mg/L)** | | | | | | | | | | | | | | |
| Ammonia | 0.01 | 0.05 | **14.28** | **0.01** J | **1.05** | **0.06** | **0.10** | **0.02** J | **0.02** J | **4.14** | NS | **0.01** J | **0.10** | <0.01 |
| Chloride | 0.05 | 0.25 | **9.41** | **2.75** | **18.00** | **7.00** | **19.09** | **3.64** | **6.89** | **23.27** | NS | **9.17** | **18.82** | <0.05 |
| Nitrate | 0.01 | 0.05 | <0.01 | <0.01 | **0.02** J | **0.03** J | <0.01 | **0.01** J | **0.03** J | <0.01 | NS | **1.23** | <0.01 | <0.01 |
| Sulfate | 0.06 | 0.30 | <0.06 | **5.55** | **238.89** | **234.85** | **146.25** | **7.08** | **11.75** | **44.52** | NS | **329.34** | **144.19** | <0.06 |
| Total Dissolved Solids (TDS) | 10 | 10 | **185.5** | **43.5** | **597.0** | **393.5** | **437.5** | **96.0** | **91.0** | **298.5** | NS | **485.5** | **473.5** | <10 |
| Total Hardness | 3 | 10 | **133.38** | **10.26** | **418.95** | **201.78** | **367.65** | **3.42** J | **13.68** | **256.5** | NS | **290.70** | **367.65** | <3 |
| **Field Measurements** | | | | | | | | | | | | | | |
| Conductivity (umhos) | N/A | N/A | 459 | 51 | 929 | 651 | 702 | 90 | 57 | 590 | NS | 596 | 699 | -- |
| Groundwater Elevation (feet) | N/A | N/A | 1.62 | 4.64 | 1.36 | 3.89 | 1.69 | 1.87 | 1.57 | 4.55 | NS | 5.04 | -- | -- |
| pH (S.U.) | N/A | N/A | 6.35 | 5.70 | 6.34 | 5.61 | 6.12 | 7.26 | 5.24 | 6.65 | NS | 5.46 | 6.11 | -- |
| Temperature (Degrees Celsius) | N/A | N/A | 17.03 | 14.62 | 15.71 | 15.26 | 15.20 | 15.40 | 15.50 | 17.73 | NS | 18.90 | 15.22 | -- |
| Sample Time (hours) | N/A | N/A | 1000 | 1000 | 1015 | 920 | 930 | 940 | 945 | 1100 | NS | 1110 | 935 | 905 |

**Notes:**

NS = Not sampled due to insufficient water.

J = Concentration is between LOD and LOQ, and is considered estimated.

LOD = Limit of Detection.

LOQ = Limit of Quantitation.

mg/L = Milligrams per liter.

N/A = Not applicable.

S.U. = Standard Units.

umhos = Micromhos.

Bold font = Detected constituent.

# Table 2
## Chesterfield Power Station - Old Ash Pond
## Groundwater Monitoring Well Report for April 4, 2012

| Parameter Name | LOD | LOQ | B-19 | B-40A | B-41A | B-41A DUP | B-42A | FIELD BLANK |
|---|---|---|---|---|---|---|---|---|
| **Metals (mg/L)** | | | | | | | | |
| Copper, Dissolved | 0.001 | 0.005 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Iron, Dissolved | 0.05 | 0.25 | **19.09** | **16.60** | **21.77** | **20.51** | **8.13** | <0.05 |
| Molybdenum, Dissolved | 0.001 | 0.005 | <0.001 | <0.001 | **0.013** | **0.012** | <0.001 | <0.001 |
| Zinc, Dissolved | 0.01 | 0.03 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| **Water Quality Parameters (mg/L)** | | | | | | | | |
| Ammonia | 0.01 | 0.05 | **0.43** | **3.62** | **1.94** | **2.50** | **1.07** | **0.01** J |
| Chloride | 0.05 | 0.25 | **17.68** | **103.72** | **191.32** | **191.65** | **16.22** | <0.05 |
| Nitrate | 0.01 | 0.05 | **0.02** J | **0.01** J | <0.01 | <0.01 | <0.01 | <0.01 |
| Sulfate | 0.06 | 0.30 | **150.95** | **6.47** | **52.53** | **52.40** | **33.25** | <0.06 |
| Total Dissolved Solids (TDS) | 10 | 10 | **385.5** | **294.0** | **599.5** | **608.2** | **218.0** | <10 |
| Total Hardness | 3 | 10 | **263.34** | **222.30** | **427.50** | **418.95** | **167.58** | <3 |
| **Field Measurements** | | | | | | | | |
| Conductivity (umhos) | N/A | N/A | 636 | 693 | 1130 | 1133 | 433 | -- |
| Groundwater Elevation (feet msl) | N/A | N/A | 16.09 | 13.48 | 5.68 | -- | 3.66 | -- |
| pH (S.U.) | N/A | N/A | 6.32 | 6.55 | 6.46 | 6.50 | 6.15 | -- |
| Sample Time (hours) | N/A | N/A | 1045 | 1030 | 1100 | 1105 | 1030 | 0900 |
| Temperature (Degrees Celsius) | N/A | N/A | 14.13 | 15.32 | 16.60 | 16.64 | 14.79 | -- |

**Notes:**

Degrees C = Degrees Celsius.
LOD = Limit of Detection.
LOQ = Limit of Quantitation.
mg/L = Milligrams per liter.
msl = Mean sea level.
N/A = Not applicable.
S.U. = Standard Units.
umhos = Micromhos.
**Bold font** = Detected constituent.

Qualifiers:
J = Concentration is between LOD and LOQ, and is considered estimated.

# Table 3
## Chesterfield Power Station - Metals Pond
## Groundwater Monitoring Well Report for April 4, 2012

| Parameter Name | Units | LOD | LOQ | MP-1R | MP-2 | MP-2 DUP | MP-3 | FIELD BLANK |
|---|---|---|---|---|---|---|---|---|
| Copper, Dissolved | mg/L | 0.001 | 0.005 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Iron, Dissolved | mg/L | 0.05 | 0.25 | <0.05 | **0.10** J | **0.08** J | **0.11** J | <0.05 |
| Chloride | mg/L | 0.05 | 0.25 | **38.76** | **31.16** | **33.46** | **248.05** | <0.05 |
| **Field Measurements** | | | | | | | | |
| Conductivity | UMHOS | N/A | N/A | 330 | 340 | 342 | 1062 | -- |
| Groundwater Elevation | feet | N/A | N/A | 31.24 | 11.28 | -- | 7.05 | -- |
| pH | S.U. | N/A | N/A | 6.66 | 6.08 | 6.10 | 5.00 | -- |
| Sample Time | hours | N/A | N/A | 1210 | 1145 | 1150 | 1155 | 0855 |
| Temperature | Degrees C | N/A | N/A | 18.63 | 17.13 | 17.10 | 17.61 | -- |

**Notes:**

Degrees C = Degrees Celsius.

J = Concentration is between LOD and LOQ, and is considered estimated.

LOD = Limit of Detection.

LOQ = Limit of Quantitation.

mg/L = Milligrams per liter.

N/A = Not applicable.

S.U. = Standard Units.

umhos = Micromhos.

**Bold font** = Detected constituent.

# Table 4
## Summary of Statistical Significance: Inter-well Analysis
## Second Quarter 2012
## Chesterfield Power Station - New Ash Pond

| Parameter Detected Above LOQ | Compliance Well | Inter-well Comparison: Statistically Significant (yes,no) |
|---|---|---|
| Barium, Dissolved | B-30A | No |
| | B-31 | No |
| | B-32 | No |
| | DM-1 | No |
| | DM-5 | No |
| | DM-6 | No |
| | DM-7 | No |
| Chromium (hexavalent) | B-30A | No |
| | B-31 | No |
| | B-32 | No |
| | DM-1 | No |
| | DM-5 | No |
| | DM-6 | No |
| | DM-7 | No |
| Iron, Dissolved | B-30A | ***Yes*** |
| | B-31 | No |
| | B-32 | No |
| | DM-1 | No |
| | DM-5 | No |
| | DM-6 | No |
| | DM-7 | No |
| Manganese, Dissolved | B-30A | No |
| | B-31 | No |
| | B-32 | No |
| | DM-1 | No |
| | DM-5 | No |
| | DM-6 | No |
| | DM-7 | No |
| Zinc | B-30A | No |
| | B-31 | No |
| | B-32 | No |
| | DM-1 | No |
| | DM-5 | No |
| | DM-6 | No |
| | DM-7 | No |
| Ammonia | B-30A | ***Yes*** |
| | B-31 | No |
| | B-32 | No |
| | DM-1 | No |
| | DM-5 | No |
| | DM-6 | No |
| | DM-7 | No |

# Table 4
## Summary of Statistical Significance: Inter-well Analysis
## Second Quarter 2012
## Chesterfield Power Station - New Ash Pond

| Parameter Detected Above LOQ | Compliance Well | Inter-well Comparison: Statistically Significant (yes,no) |
|---|---|---|
| Chloride | B-30A | No |
| | B-31 | No |
| | B-32 | No |
| | DM-1 | No |
| | DM-5 | No |
| | DM-6 | No |
| | DM-7 | No |
| Sulfate | B-30A | No |
| | B-31 | No |
| | B-32 | No |
| | DM-1 | No |
| | DM-5 | No |
| | DM-6 | No |
| | DM-7 | No |
| Total Dissolved Solids (TDS) | B-30A | No |
| | B-31 | No |
| | B-32 | No |
| | DM-1 | No |
| | DM-5 | No |
| | DM-6 | No |
| | DM-7 | No |
| Total Hardness | B-30A | No |
| | B-31 | No |
| | B-32 | No |
| | DM-1 | No |
| | DM-5 | No |
| | DM-6 | No |
| | DM-7 | No |
| Conductivity | B-30A | No |
| | B-31 | No |
| | B-32 | ***Yes*** |
| | DM-1 | No |
| | DM-5 | No |
| | DM-6 | No |
| | DM-7 | No |
| pH | B-30A | No |
| | B-31 | No |
| | B-32 | No |
| | DM-1 | No |
| | DM-5 | No |
| | DM-6 | No |
| | DM-7 | No |

**Notes:**

LOQ = Limit of Quantitation

# Inter-well Statistical Analyses
# for
# New Ash Pond

## Shapiro-Francia Test of Normality (Continued)

**Parameter: pH**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Natural Logarithm Transformation**
**Total Number of Measurements = 115**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 1.78171 | 0.173829 | 54.0196 | -71.5083 |
| 67 | 1.79342 | 0.196779 | 54.0583 | -71.1554 |
| 68 | 1.80006 | 0.219834 | 54.1067 | -70.7596 |
| 69 | 1.80006 | 0.240426 | 54.1645 | -70.3269 |
| 70 | 1.80171 | 0.263715 | 54.234 | 69.8517 |
| 71 | 1.81808 | 0.287147 | 54.3165 | 69.3297 |
| 72 | 1.8197 | 0.308108 | 54.4114 | -68.769 |
| 73 | 1.82938 | 0.331854 | 54.5215 | 68.1619 |
| 74 | 1.83098 | 0.353118 | 54.6462 | -67.5154 |
| 75 | 1.83258 | 0.377233 | 54.7885 | -66.8241 |
| 76 | 1.83578 | 0.401571 | 54.9498 | -66.0869 |
| 77 | 1.84214 | 0.423405 | 55.1291 | -65.3069 |
| 78 | 1.8516 | 0.448213 | 55.33 | 64.477 |
| 79 | 1.8516 | 0.473299 | 55.554 | -63.6006 |
| 80 | 1.85786 | 0.49585 | 55.7998 | -62.6794 |
| 81 | 1.85786 | 0.521527 | 56.0718 | -61.7105 |
| 82 | 1.85942 | 0.544642 | 56.3685 | -60.6978 |
| 83 | 1.86253 | 0.570999 | 56.6945 | -59.6343 |
| 84 | 1.86253 | 0.597761 | 57.0518 | -58.5209 |
| 85 | 1.86872 | 0.621911 | 57.4386 | -57.3587 |
| 86 | 1.87026 | 0.649522 | 57.8605 | -56.144 |
| 87 | 1.88099 | 0.67449 | 58.3154 | -54.8752 |
| 88 | 1.88251 | 0.703089 | 58.8097 | -53.5517 |
| 89 | 1.88251 | 0.732275 | 59.346 | -52.1731 |
| 90 | 1.88707 | 0.758753 | 59.9217 | -50.7413 |
| 91 | 1.88858 | 0.789191 | 60.5445 | -49.2509 |
| 92 | 1.89311 | 0.820379 | 61.2175 | -47.6978 |
| 93 | 1.89762 | 0.848786 | 61.938 | -46.0871 |
| 94 | 1.90061 | 0.881587 | 62.7152 | -44.4116 |
| 95 | 1.90061 | 0.911562 | 63.5461 | -42.6791 |
| 96 | 1.90211 | 0.946291 | 64.4416 | -40.8791 |
| 97 | 1.90658 | 0.982202 | 65.4063 | -39.0065 |
| 98 | 1.90806 | 1.01522 | 66.437 | 37.0694 |
| 99 | 1.90954 | 1.05375 | 67.5473 | -35.0572 |
| 100 | 1.91545 | 1.0939 | 68.744 | 32.9619 |
| 101 | 1.91839 | 1.13113 | 70.0234 | -30.7919 |
| 102 | 1.91986 | 1.17499 | 71.404 | -28.5361 |
| 103 | 1.92132 | 1.21596 | 72.8826 | -26.1999 |
| 104 | 1.92571 | 1.26464 | 74.4819 | -23.7645 |
| 105 | 1.93152 | 1.31652 | 76.2151 | -21.2216 |
| 106 | 1.93586 | 1.36581 | 78.0805 | -18.5776 |
| 107 | 1.94162 | 1.42554 | 80.1127 | -15.8098 |
| 108 | 1.94734 | 1.49085 | 82.3354 | -12.9066 |
| 109 | 1.96009 | 1.55477 | 84.7527 | 9.85908 |
| 110 | 1.9615 | 1.63524 | 87.4267 | -6.65157 |
| 111 | 1.96851 | 1.71688 | 90.3744 | 3.27186 |
| 112 | 1.97547 | 1.82501 | 93.705 | 0.333382 |
| 113 | 1.981 | 1.95996 | 97.5465 | 4.21607 |
| 114 | 2.08194 | 2.12007 | 102.041 | 8.62992 |
| 115 | 2.11384 | 2.40892 | 107.844 | 13.722 |

Data Set Standard Deviation = 0.126361
Numerator = 188.293
Denominator = 196.305
W Statistic = 0.959191 = 188.293 / 196.305

5% Critical value of 0.976 exceeds 0.959191
Evidence of non-normality at 95% level of significance

**Shapiro-Francia Test of Normality**
**Parameter: pH**
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 115

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 1.50851 | -2.40892 | 5.80292 | -3.63389 |
| 2 | 1.53902 | -2.12007 | 10.2976 | -6.89671 |
| 3 | 1.56862 | -1.95996 | 14.1391 | -9.97114 |
| 4 | 1.57691 | -1.82501 | 17.4697 | -12.849 |
| 5 | 1.58515 | -1.71688 | 20.4174 | -15.5705 |
| 6 | 1.58719 | -1.63524 | 23.0914 | -18.166 |
| 7 | 1.59331 | -1.55477 | 25.5087 | -20.6432 |
| 8 | 1.59534 | -1.49085 | 27.7313 | -23.0216 |
| 9 | 1.59534 | -1.42554 | 29.7635 | -25.2958 |
| 10 | 1.60944 | -1.36581 | 31.6289 | -27.494 |
| 11 | 1.62137 | -1.31652 | 33.3622 | -29.6286 |
| 12 | 1.62924 | -1.26464 | 34.9615 | -31.689 |
| 13 | 1.6312 | -1.21596 | 36.4401 | -33.6725 |
| 14 | 1.63511 | -1.17499 | 37.8206 | -35.5937 |
| 15 | 1.63511 | -1.13113 | 39.1001 | -37.4432 |
| 16 | 1.639 | -1.0939 | 40.2967 | -39.2361 |
| 17 | 1.639 | -1.05375 | 41.4071 | -40.9632 |
| 18 | 1.639 | -1.01522 | 42.4378 | -42.6271 |
| 19 | 1.64094 | -0.982202 | 43.4025 | -44.2389 |
| 20 | 1.64287 | -0.946291 | 44.298 | -45.7935 |
| 21 | 1.64287 | -0.911562 | 45.1289 | -47.2911 |
| 22 | 1.64481 | -0.881587 | 45.9061 | -48.7411 |
| 23 | 1.64481 | -0.848786 | 46.6265 | -50.1372 |
| 24 | 1.64673 | -0.820379 | 47.2996 | -51.4881 |
| 25 | 1.65441 | -0.789191 | 47.9224 | -52.7938 |
| 26 | 1.65632 | -0.758753 | 48.4981 | -54.0505 |
| 27 | 1.65823 | -0.732275 | 49.0343 | -55.2648 |
| 28 | 1.65823 | -0.703089 | 49.5286 | -56.4307 |
| 29 | 1.65823 | -0.67449 | 49.9836 | -57.5491 |
| 30 | 1.66582 | -0.649522 | 50.4055 | -58.6311 |
| 31 | 1.67147 | -0.621911 | 50.7922 | -59.6706 |
| 32 | 1.67147 | -0.597761 | 51.1496 | -60.6698 |
| 33 | 1.67147 | -0.570999 | 51.4756 | -61.6242 |
| 34 | 1.67147 | -0.544642 | 51.7722 | -62.5345 |
| 35 | 1.67147 | -0.521527 | 52.0442 | -63.4063 |
| 36 | 1.67335 | -0.49585 | 52.2901 | -64.236 |
| 37 | 1.68083 | -0.473299 | 52.5141 | -65.0315 |
| 38 | 1.68083 | -0.448213 | 52.715 | -65.7849 |
| 39 | 1.6864 | -0.423405 | 52.8943 | -66.4989 |
| 40 | 1.6864 | -0.401571 | 53.0555 | -67.1761 |
| 41 | 1.6864 | -0.377233 | 53.1978 | -67.8123 |
| 42 | 1.68825 | -0.353118 | 53.3225 | -68.4085 |
| 43 | 1.69378 | -0.331854 | 53.4326 | -68.9705 |
| 44 | 1.69562 | -0.308108 | 53.5276 | -69.493 |
| 45 | 1.69745 | -0.287147 | 53.61 | -69.9804 |
| 46 | 1.69928 | -0.263715 | 53.6796 | -70.4285 |
| 47 | 1.70111 | -0.240426 | 53.7374 | -70.8375 |
| 48 | 1.70111 | -0.219834 | 53.7857 | -71.2115 |
| 49 | 1.70293 | -0.196779 | 53.8244 | -71.5466 |
| 50 | 1.70475 | -0.173829 | 53.8546 | -71.8429 |
| 51 | 1.71199 | -0.153505 | 53.8782 | -72.1057 |
| 52 | 1.71199 | -0.130716 | 53.8953 | -72.3295 |
| 53 | 1.71199 | -0.110516 | 53.9075 | -72.5187 |
| 54 | 1.7174 | -0.0878447 | 53.9152 | -72.6696 |
| 55 | 1.7174 | -0.0652187 | 53.9195 | -72.7816 |
| 56 | 1.72277 | -0.0451348 | 53.9215 | -72.8593 |
| 57 | 1.72633 | -0.0225612 | 53.922 | -72.8983 |
| 58 | 1.72811 | 0 | 53.922 | -72.8983 |
| 59 | 1.72811 | 0.0225612 | 53.9225 | -72.8593 |
| 60 | 1.72988 | 0.0451348 | 53.9246 | -72.7812 |
| 61 | 1.73342 | 0.0652187 | 53.9288 | -72.6682 |
| 62 | 1.73519 | 0.0878447 | 53.9365 | -72.5157 |
| 63 | 1.74746 | 0.110516 | 53.9488 | -72.3226 |
| 64 | 1.76815 | 0.130716 | 53.9658 | -72.0915 |
| 65 | 1.78171 | 0.153505 | 53.9894 | -71.818 |

## Shapiro-Francia Test of Normality (Continued)

Parameter: pH
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 115

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 5.94 | 0.173829 | 54.0196 | -223.265 |
| 67 | 6.01 | 0.196779 | 54.0583 | -222.082 |
| 68 | 6.05 | 0.219834 | 54.1067 | -220.752 |
| 69 | 6.05 | 0.240426 | 54.1645 | -219.298 |
| 70 | 6.06 | 0.263715 | 54.234 | -217.7 |
| 71 | 6.16 | 0.287147 | 54.3165 | -215.931 |
| 72 | 6.17 | 0.308108 | 54.4114 | -214.03 |
| 73 | 6.23 | 0.331854 | 54.5215 | -211.962 |
| 74 | 6.24 | 0.353118 | 54.6462 | -209.759 |
| 75 | 6.25 | 0.377233 | 54.7885 | -207.401 |
| 76 | 6.27 | 0.401571 | 54.9498 | -204.883 |
| 77 | 6.31 | 0.423405 | 55.1291 | -202.212 |
| 78 | 6.37 | 0.448213 | 55.33 | -199.357 |
| 79 | 6.37 | 0.473299 | 55.554 | -196.342 |
| 80 | 6.41 | 0.49585 | 55.7998 | -193.163 |
| 81 | 6.41 | 0.521527 | 56.0718 | -189.82 |
| 82 | 6.42 | 0.544642 | 56.3685 | -186.324 |
| 83 | 6.44 | 0.570999 | 56.6945 | -182.646 |
| 84 | 6.44 | 0.597761 | 57.0518 | -178.797 |
| 85 | 6.48 | 0.621911 | 57.4386 | -174.767 |
| 86 | 6.49 | 0.649522 | 57.8605 | -170.552 |
| 87 | 6.56 | 0.67449 | 58.3154 | -166.127 |
| 88 | 6.57 | 0.703089 | 58.8097 | -161.508 |
| 89 | 6.57 | 0.732275 | 59.346 | -156.696 |
| 90 | 6.6 | 0.758753 | 59.9217 | -151.689 |
| 91 | 6.61 | 0.789191 | 60.5445 | -146.472 |
| 92 | 6.64 | 0.820379 | 61.2175 | -141.025 |
| 93 | 6.67 | 0.848786 | 61.938 | 135.363 |
| 94 | 6.69 | 0.881587 | 62.7152 | -129.466 |
| 95 | 6.69 | 0.911562 | 63.5461 | -123.367 |
| 96 | 6.7 | 0.946291 | 64.4416 | -117.027 |
| 97 | 6.73 | 0.982202 | 65.4063 | -110.417 |
| 98 | 6.74 | 1.01522 | 66.437 | -103.574 |
| 99 | 6.75 | 1.05375 | 67.5473 | -96.4616 |
| 100 | 6.79 | 1.0939 | 68.744 | -89.034 |
| 101 | 6.81 | 1.13113 | 70.0234 | -81.331 |
| 102 | 6.82 | 1.17499 | 71.404 | -73.3176 |
| 103 | 6.83 | 1.21596 | 72.8826 | -65.0126 |
| 104 | 6.86 | 1.26464 | 74.4819 | -56.3371 |
| 105 | 6.9 | 1.31652 | 76.2151 | -47.2531 |
| 106 | 6.93 | 1.36581 | 78.0805 | -37.7881 |
| 107 | 6.97 | 1.42554 | 80.1127 | -27.8521 |
| 108 | 7.01 | 1.49085 | 82.3354 | 17.4012 |
| 109 | 7.1 | 1.55477 | 84.7527 | -6.36229 |
| 110 | 7.11 | 1.63524 | 87.4267 | 5.26423 |
| 111 | 7.16 | 1.71688 | 90.3744 | 17.5571 |
| 112 | 7.21 | 1.82501 | 93.705 | 30.7154 |
| 113 | 7.25 | 1.95996 | 97.5465 | 44.9251 |
| 114 | 8.02 | 2.12007 | 102.041 | 61.9281 |
| 115 | 8.28 | 2.40892 | 107.844 | 81.874 |

Data Set Standard Deviation = 0.760172
Numerator = 6703.35
Denominator = 7104.36
W Statistic = 0.943554 = 6703.35 / 7104.36

5% Critical value of 0.976 exceeds 0.943554
Evidence of non-normality at 95% level of significance

**Shapiro-Francia Test of Normality**
**Parameter: pH**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Total Number of Measurements = 115**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 4.52 | -2.40892 | 5.80292 | -10.8883 |
| 2 | 4.66 | -2.12007 | 10.2976 | -20.7679 |
| 3 | 4.8 | -1.95996 | 14.1391 | -30.1757 |
| 4 | 4.84 | -1.82501 | 17.4697 | -39.0087 |
| 5 | 4.88 | -1.71688 | 20.4174 | -47.3871 |
| 6 | 4.89 | 1.63524 | 23.0914 | -55.3834 |
| 7 | 4.92 | -1.55477 | 25.5087 | -63.0329 |
| 8 | 4.93 | -1.49085 | 27.7313 | -70.3828 |
| 9 | 4.93 | -1.42554 | 29.7635 | -77.4107 |
| 10 | 5 | -1.36581 | 31.6289 | -84.2397 |
| 11 | 5.06 | -1.31652 | 33.3622 | -90.9013 |
| 12 | 5.1 | -1.26464 | 34.9615 | -97.351 |
| 13 | 5.11 | -1.21596 | 36.4401 | -103.565 |
| 14 | 5.13 | -1.17499 | 37.8206 | -109.592 |
| 15 | 5.13 | -1.13113 | 39.1001 | -115.395 |
| 16 | 5.15 | -1.0939 | 40.2967 | -121.029 |
| 17 | 5.15 | -1.05375 | 41.4071 | -126.455 |
| 18 | 5.15 | -1.01522 | 42.4378 | -131.684 |
| 19 | 5.16 | -0.982202 | 43.4025 | -136.752 |
| 20 | 5.17 | -0.946291 | 44.298 | -141.644 |
| 21 | 5.17 | -0.911562 | 45.1289 | -146.357 |
| 22 | 5.18 | -0.881587 | 45.9061 | -150.924 |
| 23 | 5.18 | -0.848786 | 46.6265 | -155.32 |
| 24 | 5.19 | -0.820379 | 47.2996 | -159.578 |
| 25 | 5.23 | -0.789191 | 47.9224 | -163.706 |
| 26 | 5.24 | -0.758753 | 48.4981 | -167.681 |
| 27 | 5.25 | -0.732275 | 49.0343 | -171.526 |
| 28 | 5.25 | -0.703089 | 49.5286 | -175.217 |
| 29 | 5.25 | -0.67449 | 49.9836 | -178.758 |
| 30 | 5.29 | -0.649522 | 50.4055 | -182.194 |
| 31 | 5.32 | -0.621911 | 50.7922 | -185.503 |
| 32 | 5.32 | -0.597761 | 51.1496 | -188.683 |
| 33 | 5.32 | -0.570999 | 51.4756 | -191.72 |
| 34 | 5.32 | -0.544642 | 51.7722 | -194.618 |
| 35 | 5.32 | -0.521527 | 52.0442 | -197.392 |
| 36 | 5.33 | -0.49585 | 52.2901 | -200.035 |
| 37 | 5.37 | -0.473299 | 52.5141 | -202.577 |
| 38 | 5.37 | -0.448213 | 52.715 | -204.984 |
| 39 | 5.4 | -0.423405 | 52.8943 | -207.27 |
| 40 | 5.4 | -0.401571 | 53.0555 | -209.439 |
| 41 | 5.4 | -0.377233 | 53.1978 | -211.476 |
| 42 | 5.41 | -0.353118 | 53.3225 | -213.386 |
| 43 | 5.44 | -0.331854 | 53.4326 | -215.191 |
| 44 | 5.45 | -0.308108 | 53.5276 | -216.871 |
| 45 | 5.46 | -0.287147 | 53.61 | -218.438 |
| 46 | 5.47 | -0.263715 | 53.6796 | -219.881 |
| 47 | 5.48 | -0.240426 | 53.7374 | -221.199 |
| 48 | 5.48 | -0.219834 | 53.7857 | -222.403 |
| 49 | 5.49 | -0.196779 | 53.8244 | -223.484 |
| 50 | 5.5 | -0.173829 | 53.8546 | -224.44 |
| 51 | 5.54 | -0.153505 | 53.8782 | -225.29 |
| 52 | 5.54 | -0.130716 | 53.8953 | -226.014 |
| 53 | 5.54 | -0.110516 | 53.9075 | -226.626 |
| 54 | 5.57 | -0.0878447 | 53.9152 | -227.116 |
| 55 | 5.57 | -0.0652187 | 53.9195 | -227.479 |
| 56 | 5.6 | -0.0451348 | 53.9215 | -227.732 |
| 57 | 5.62 | -0.0225612 | 53.922 | -227.859 |
| 58 | 5.63 | 0 | 53.922 | -227.859 |
| 59 | 5.63 | 0.0225612 | 53.9225 | -227.732 |
| 60 | 5.64 | 0.0451348 | 53.9246 | -227.477 |
| 61 | 5.66 | 0.0652187 | 53.9288 | -227.108 |
| 62 | 5.67 | 0.0878447 | 53.9365 | -226.61 |
| 63 | 5.74 | 0.110516 | 53.9488 | -225.975 |
| 64 | 5.86 | 0.130716 | 53.9658 | -225.209 |
| 65 | 5.94 | 0.153505 | 53.9894 | -224.298 |

**Rosner's Test for Outliers (Continued)**
**Parameter: pH**
**Background Locations**
**Original Data (Not Transformed)**

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Iteration i = 3
Mean of 113 measurements = 5.84558
Std Dev = 0.703349
x(i+1) = 4.52 from measurement 10/2/2002 from location B-52
Rosner Statistic R = |4.52 - 5.84558|/0.703349 = 1.88466
Lambda(116, 4, 0.05) = 3.4148
1.88466 < 3.4148 -- No outliers detected for i = 3

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Iteration i = 2
Mean of 114 measurements = 5.86465
Std Dev = 0.729244
x(i+1) = 8.02 from measurement 1/7/2004 from location B-50
Rosner Statistic R = |8.02 - 5.86465|/0.729244 = 2.9556
Lambda(116, 3, 0.05) = 3.4216
2.9556 < 3.4216 -- No outliers detected for i = 2

---

Iteration i = 1
Mean of 115 measurements = 5.88565
Std Dev = 0.760172
x(i+1) = 8.28 from measurement 7/15/2009 from location B-50
Rosner Statistic R = |8.28 - 5.88565|/0.760172 = 3.14974
Lambda(116, 2, 0.05) = 3.4216
3.14974 < 3.4216 -- No outliers detected for i = 1

---

Iteration i = 0
Mean of 116 measurements = 5.91862
Std Dev = 0.836014
x(i+1) = 9.71 from measurement 7/7/2010 from location B-50
Rosner Statistic R = |9.71 - 5.91862|/0.836014 = 4.53507
Lambda(116, 1, 0.05) = 3.4248
**4.53507 > 3.4248 -- Measurement 7/7/2010 for location B-50 is an outlier**

**1 OUTLIER DETECTED - EXTREME VALUE IDENTIFIED; WILL REMOVE**

**Rosner's Test for Outliers**
**Parameter: pH**
**Background Locations**
**Original Data (Not Transformed)**

Data set mean = 5.91862

10 most extreme of 116 measurements
by order of magnitude difference from the mean

| | | | | |
|---|---|---|---|---|
| 1 | 7/7/2010 | B-50 | 9.71 | 3.79138 |
| 2 | 7/15/2009 | B-50 | 8.28 | 2.36138 |
| 3 | 1/7/2004 | B-50 | 8.02 | 2.10138 |
| 4 | 10/2/2002 | B-52 | 4.52 | -1.39862 |
| 5 | 4/13/2011 | B-50 | 7.25 | 1.33138 |
| 6 | 7/7/2010 | B-52 | 7.21 | 1.29138 |
| 7 | 1/8/2003 | B-51 | 4.66 | -1.25862 |
| 8 | 11/15/2001 | B-50 | 7.16 | 1.24138 |
| 9 | 4/7/2004 | B-50 | 7.11 | 1.19138 |
| 10 | 4/4/2007 | B-50 | 7.1 | 1.18138 |

---------------------------------------------
Iteration i = 9
Mean of 107 measurements = 5.81907
Std Dev = 0.651616
x(i+1) = 7.1 from measurement 4/4/2007 from location B-50
Rosner Statistic R = |7.1 - 5.81907|/0.651616 = 1.96578
Lambda(116, 10, 0.05) = 3.398
1.96578 < 3.398 -- No outliers detected for i = 9

---------------------------------------------
Iteration i = 8
Mean of 108 measurements = 5.83102
Std Dev = 0.660352
x(i+1) = 7.11 from measurement 4/7/2004 from location B-50
Rosner Statistic R = |7.11 - 5.83102|/0.660352 = 1.93682
Lambda(116, 9, 0.05) = 3.40136
1.93682 < 3.40136 -- No outliers detected for i = 8

---------------------------------------------
Iteration i = 7
Mean of 109 measurements = 5.84321
Std Dev = 0.669501
x(i+1) = 7.16 from measurement 11/15/2001 from location B-50
Rosner Statistic R = |7.16 - 5.84321|/0.669501 = 1.96682
Lambda(116, 8, 0.05) = 3.40472
1.96682 < 3.40472 -- No outliers detected for i = 7

---------------------------------------------
Iteration i = 6
Mean of 110 measurements = 5.83245
Std Dev = 0.675904
x(i+1) = 4.66 from measurement 1/8/2003 from location B-51
Rosner Statistic R = |4.66 - 5.83245|/0.675904 = 1.73465
Lambda(116, 7, 0.05) = 3.40808
1.73465 < 3.40808 -- No outliers detected for i = 6

---------------------------------------------
Iteration i = 5
Mean of 111 measurements = 5.84486
Std Dev = 0.685411
x(i+1) = 7.21 from measurement 7/7/2010 from location B-52
Rosner Statistic R = |7.21 - 5.84486|/0.685411 = 1.9917
Lambda(116, 6, 0.05) = 3.41144
1.9917 < 3.41144 -- No outliers detected for i = 5

---------------------------------------------
Iteration i = 4
Mean of 112 measurements = 5.85741
Std Dev = 0.695115
x(i+1) = 7.25 from measurement 4/13/2011 from location B-50
Rosner Statistic R = |7.25 - 5.85741|/0.695115 = 2.00339
Lambda(116, 5, 0.05) = 3.4148
2.00339 < 3.4148 -- No outliers detected for i = 4

**Concentrations (S.U.) - Continued**
**Parameter: pH**
Original Data (Not Transformed)
Percent Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| | | | 10/22/2008 | 5.5 | 5.5 |
| | | | 1/13/2009 | 6.61 | 6.61 |
| | | | 4/8/2009 | 5.25 | 5.25 |
| | | | 7/15/2009 | 6.44 | 6.44 |
| | | | 1/7/2010 | 5.13 | 5.13 |
| | | | 4/7/2010 | 5.94 | 5.94 |
| | | | 7/7/2010 | 6.42 | 6.42 |
| | | | 8/16/2011 | 5.23 | 5.23 |
| | | | 10/26/2011 | 5.11 | 5.11 |
| B-50 | 42 | 0 (0%) | 11/15/2001 | 7.16 | 7.16 |
| | | | 1/16/2002 | 6.69 | 6.69 |
| | | | 4/3/2002 | 6.41 | 6.41 |
| | | | 7/2/2002 | 6.37 | 6.37 |
| | | | 10/2/2002 | 6.31 | 6.31 |
| | | | 1/8/2003 | 6.05 | 6.05 |
| | | | 4/2/2003 | 6.82 | 6.82 |
| | | | 7/23/2003 | 6.93 | 6.93 |
| | | | 10/2/2003 | 6.97 | 6.97 |
| | | | 1/7/2004 | 8.02 | 8.02 |
| | | | 4/7/2004 | 7.11 | 7.11 |
| | | | 7/13/2004 | 6.06 | 6.06 |
| | | | 10/6/2004 | 6.37 | 6.37 |
| | | | 1/6/2005 | 6.73 | 6.73 |
| | | | 4/6/2005 | 6.25 | 6.25 |
| | | | 7/27/2005 | 6.67 | 6.67 |
| | | | 10/13/2005 | 6.27 | 6.27 |
| | | | 1/5/2006 | 6.79 | 6.79 |
| | | | 4/6/2006 | 6.7 | 6.7 |
| | | | 7/25/2006 | 6.64 | 6.64 |
| | | | 10/11/2006 | 7.01 | 7.01 |
| | | | 1/4/2007 | 6.83 | 6.83 |
| | | | 4/4/2007 | 7.1 | 7.1 |
| | | | 7/12/2007 | 6.44 | 6.44 |
| | | | 10/10/2007 | 5.94 | 5.94 |
| | | | 1/16/2008 | 6.16 | 6.16 |
| | | | 4/3/2008 | 6.74 | 6.74 |
| | | | 7/23/2008 | 6.48 | 6.48 |
| | | | 10/22/2008 | 6.9 | 6.9 |
| | | | 1/13/2009 | 6.56 | 6.56 |
| | | | 4/8/2009 | 6.81 | 6.81 |
| | | | 7/15/2009 | 8.28 | 8.28 |
| | | | 10/8/2009 | 6.69 | 6.69 |
| | | | 1/7/2010 | 6.57 | 6.57 |
| | | | 4/7/2010 | 6.41 | 6.41 |
| | | | 7/7/2010 | 9.71 | 9.71 |
| | | | 12/8/2010 | 6.49 | 6.49 |
| | | | 2/3/2011 | 6.23 | 6.23 |
| | | | 4/13/2011 | 7.25 | 7.25 |
| | | | 8/16/2011 | 6.86 | 6.86 |
| | | | 10/26/2011 | 6.6 | 6.6 |
| | | | 1/18/2012 | 6.75 | 6.75 |

**Concentrations (S.U.)**
**Parameter: pH**
**Original Data (Not Transformed)**
**Percent Non-Detects: 0%**
**Total Background Measurements: 116**
**There are 3 background locations**

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-52 | 42 | 0 (0%) | 11/15/2001 | 5 | 5 |
| | | | 1/16/2002 | 5.25 | 5.25 |
| | | | 4/3/2002 | 5.64 | 5.64 |
| | | | 7/2/2002 | 4.89 | 4.89 |
| | | | 10/2/2002 | 4.52 | 4.52 |
| | | | 1/8/2003 | 5.4 | 5.4 |
| | | | 4/2/2003 | 5.29 | 5.29 |
| | | | 7/23/2003 | 5.63 | 5.63 |
| | | | 10/2/2003 | 5.49 | 5.49 |
| | | | 1/7/2004 | 5.66 | 5.66 |
| | | | 4/7/2004 | 5.57 | 5.57 |
| | | | 7/13/2004 | 4.92 | 4.92 |
| | | | 10/6/2004 | 4.88 | 4.88 |
| | | | 1/6/2005 | 6.24 | 6.24 |
| | | | 4/6/2005 | 5.63 | 5.63 |
| | | | 7/27/2005 | 5.13 | 5.13 |
| | | | 10/13/2005 | 5.54 | 5.54 |
| | | | 1/5/2006 | 5.32 | 5.32 |
| | | | 4/6/2006 | 5.15 | 5.15 |
| | | | 7/25/2006 | 5.15 | 5.15 |
| | | | 10/11/2006 | 5.54 | 5.54 |
| | | | 1/4/2007 | 5.32 | 5.32 |
| | | | 4/4/2007 | 5.32 | 5.32 |
| | | | 7/12/2007 | 6.01 | 6.01 |
| | | | 10/10/2007 | 5.25 | 5.25 |
| | | | 1/16/2008 | 5.45 | 5.45 |
| | | | 4/3/2008 | 5.6 | 5.6 |
| | | | 7/23/2008 | 5.15 | 5.15 |
| | | | 10/22/2008 | 5.57 | 5.57 |
| | | | 1/13/2009 | 4.84 | 4.84 |
| | | | 4/8/2009 | 5.44 | 5.44 |
| | | | 7/15/2009 | 6.57 | 6.57 |
| | | | 10/8/2009 | 5.47 | 5.47 |
| | | | 1/7/2010 | 5.48 | 5.48 |
| | | | 4/7/2010 | 6.05 | 6.05 |
| | | | 7/7/2010 | 7.21 | 7.21 |
| | | | 12/8/2010 | 5.1 | 5.1 |
| | | | 2/3/2011 | 5.46 | 5.46 |
| | | | 4/13/2011 | 4.93 | 4.93 |
| | | | 8/16/2011 | 5.33 | 5.33 |
| | | | 10/26/2011 | 4.93 | 4.93 |
| | | | 1/18/2012 | 5.24 | 5.24 |
| B-51 | 32 | 0 (0%) | 11/15/2001 | 5.32 | 5.32 |
| | | | 10/2/2002 | 4.8 | 4.8 |
| | | | 1/8/2003 | 4.66 | 4.66 |
| | | | 4/2/2003 | 6.17 | 6.17 |
| | | | 7/23/2003 | 5.4 | 5.4 |
| | | | 10/2/2003 | 5.67 | 5.67 |
| | | | 1/7/2004 | 5.37 | 5.37 |
| | | | 4/7/2004 | 5.17 | 5.17 |
| | | | 7/13/2004 | 5.17 | 5.17 |
| | | | 10/6/2004 | 5.06 | 5.06 |
| | | | 1/6/2005 | 5.18 | 5.18 |
| | | | 4/6/2005 | 5.41 | 5.41 |
| | | | 7/27/2005 | 5.86 | 5.86 |
| | | | 10/13/2005 | 5.37 | 5.37 |
| | | | 1/5/2006 | 5.16 | 5.16 |
| | | | 4/6/2006 | 5.19 | 5.19 |
| | | | 7/25/2006 | 5.74 | 5.74 |
| | | | 10/11/2006 | 5.54 | 5.54 |
| | | | 1/4/2007 | 5.32 | 5.32 |
| | | | 4/4/2007 | 5.4 | 5.4 |
| | | | 7/12/2007 | 5.18 | 5.18 |
| | | | 10/10/2007 | 5.62 | 5.62 |
| | | | 7/23/2008 | 5.48 | 5.48 |

**Non-Parametric Prediction Interval**
**Inter-Well Comparison**
**Parameter: Conductivity**
**Original Data (Not Transformed)**

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
**Maximum Background Value = 880**
Confidence Level = 99%
False Positive Rate = 1%

| Location | Date | Count | Mean | Significant |
|---|---|---|---|---|
| B-30A | 4/4/2012 | 1 | 459 | FALSE |
| B-32 | 4/4/2012 | 1 | 929 | **TRUE** |
| B-31 | 4/4/2012 | 1 | 51 | FALSE |
| DM-1 | 4/4/2012 | 1 | 651 | FALSE |
| DM-7 | 4/4/2012 | 1 | 57 | FALSE |
| DM-6 | 4/4/2012 | 1 | 90 | FALSE |
| DM-5 | 4/4/2012 | 1 | 702 | FALSE |

**Shapiro-Francia Test of Normality (Continued)**
**Parameter: Conductivity**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Natural Logarithm Transformation**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 6.42162 | 0.163659 | 54.4516 | -236.746 |
| 67 | 6.42487 | 0.184017 | 54.4854 | -235.564 |
| 68 | 6.42649 | 0.207012 | 54.5283 | -234.234 |
| 69 | 6.42811 | 0.227545 | 54.5801 | -232.771 |
| 70 | 6.44095 | 0.250759 | 54.643 | -231.156 |
| 71 | 6.44889 | 0.271509 | 54.7167 | -229.405 |
| 72 | 6.48004 | 0.294992 | 54.8037 | -227.493 |
| 73 | 6.48768 | 0.316004 | 54.9036 | -225.443 |
| 74 | 6.49979 | 0.33981 | 55.019 | -223.235 |
| 75 | 6.50429 | 0.363809 | 55.1514 | -220.868 |
| 76 | 6.50877 | 0.385321 | 55.2999 | -218.36 |
| 77 | 6.51471 | 0.409735 | 55.4677 | -215.691 |
| 78 | 6.51767 | 0.431644 | 55.6541 | -212.878 |
| 79 | 6.52503 | 0.456542 | 55.8625 | -209.899 |
| 80 | 6.52649 | 0.478914 | 56.0918 | -206.773 |
| 81 | 6.53379 | 0.504372 | 56.3462 | -203.478 |
| 82 | 6.53669 | 0.52728 | 56.6243 | -200.031 |
| 83 | 6.53814 | 0.553384 | 56.9305 | -196.413 |
| 84 | 6.55108 | 0.576911 | 57.2633 | -192.634 |
| 85 | 6.55393 | 0.603765 | 57.6278 | -188.677 |
| 86 | 6.56808 | 0.631062 | 58.0261 | -184.532 |
| 87 | 6.57647 | 0.655726 | 58.4561 | -180.219 |
| 88 | 6.57647 | 0.68396 | 58.9239 | -175.721 |
| 89 | 6.57786 | 0.709522 | 59.4273 | -171.054 |
| 90 | 6.59987 | 0.738846 | 59.9732 | -166.178 |
| 91 | 6.59987 | 0.765456 | 60.5591 | -161.126 |
| 92 | 6.6053 | 0.796056 | 61.1928 | -155.868 |
| 93 | 6.61338 | 0.823893 | 61.8716 | -150.419 |
| 94 | 6.61473 | 0.855996 | 62.6043 | -144.757 |
| 95 | 6.61874 | 0.885291 | 63.3881 | -138.897 |
| 96 | 6.62007 | 0.919183 | 64.233 | -132.812 |
| 97 | 6.62007 | 0.954165 | 65.1434 | -126.496 |
| 98 | 6.62007 | 0.986272 | 66.1161 | -119.966 |
| 99 | 6.62274 | 1.02365 | 67.164 | -113.187 |
| 100 | 6.63332 | 1.05812 | 68.2836 | -106.168 |
| 101 | 6.64249 | 1.09847 | 69.4903 | -98.8716 |
| 102 | 6.64769 | 1.1359 | 70.7805 | -91.3205 |
| 103 | 6.65544 | 1.18 | 72.1729 | -83.4671 |
| 104 | 6.66313 | 1.22123 | 73.6643 | -75.3299 |
| 105 | 6.66696 | 1.27024 | 75.2778 | -66.8613 |
| 106 | 6.67077 | 1.31652 | 77.011 | -58.0791 |
| 107 | 6.69208 | 1.3722 | 78.894 | -48.8962 |
| 108 | 6.69703 | 1.4325 | 80.9461 | -39.3026 |
| 109 | 6.70441 | 1.49085 | 83.1687 | -29.3073 |
| 110 | 6.72623 | 1.56322 | 85.6124 | -18.7927 |
| 111 | 6.74406 | 1.63524 | 88.2864 | -7.76463 |
| 112 | 6.74876 | 1.72793 | 91.2721 | 3.89676 |
| 113 | 6.7511 | 1.82501 | 94.6027 | 16.2176 |
| 114 | 6.75344 | 1.95996 | 98.4442 | 29.454 |
| 115 | 6.77537 | 2.12007 | 102.939 | 43.8183 |
| 116 | 6.77992 | 2.40892 | 108.742 | 60.1506 |

Data Set Standard Deviation = 0.596736
Numerator = 3618.09
Denominator = 4453.07
W Statistic = 0.812495 = 3618.09 / 4453.07

5% Critical value of 0.976 exceeds 0.812495
Evidence of non-normality at 95% level of significance

## Shapiro-Francia Test of Normality

**Parameter: Conductivity**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Natural Logarithm Transformation**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 4.06044 | -2.40892 | 5.80292 | -9.7813 |
| 2 | 4.68213 | -2.12007 | 10.2976 | -19.7077 |
| 3 | 5.07517 | -1.95996 | 14.1391 | -29.6549 |
| 4 | 5.20949 | -1.82501 | 17.4697 | -39.1622 |
| 5 | 5.20949 | -1.72793 | 20.4554 | -48.1639 |
| 6 | 5.22036 | -1.63524 | 23.1294 | -56.7004 |
| 7 | 5.22036 | -1.56322 | 25.5731 | -64.8609 |
| 8 | 5.22575 | -1.49085 | 27.7957 | -72.6518 |
| 9 | 5.23111 | -1.4325 | 29.8478 | -80.1453 |
| 10 | 5.25227 | -1.3722 | 31.7308 | -87.3525 |
| 11 | 5.26269 | -1.31652 | 33.464 | -94.281 |
| 12 | 5.273 | -1.27024 | 35.0775 | -100.979 |
| 13 | 5.273 | -1.22123 | 36.5689 | -107.418 |
| 14 | 5.273 | -1.18 | 37.9613 | -113.641 |
| 15 | 5.27811 | -1.1359 | 39.2515 | -119.636 |
| 16 | 5.2832 | -1.09847 | 40.4582 | -125.439 |
| 17 | 5.28827 | -1.05812 | 41.5778 | -131.035 |
| 18 | 5.28827 | -1.02365 | 42.6257 | -136.448 |
| 19 | 5.2933 | -0.986272 | 43.5984 | -141.669 |
| 20 | 5.2933 | -0.954165 | 44.5088 | -146.72 |
| 21 | 5.29832 | -0.919183 | 45.3537 | -151.59 |
| 22 | 5.3033 | -0.885291 | 46.1375 | -156.285 |
| 23 | 5.32301 | -0.855996 | 46.8702 | -160.841 |
| 24 | 5.32301 | -0.823893 | 47.549 | -165.227 |
| 25 | 5.33272 | -0.796056 | 48.1827 | -169.472 |
| 26 | 5.33754 | -0.765456 | 48.7686 | -173.558 |
| 27 | 5.34233 | -0.738846 | 49.3145 | -177.505 |
| 28 | 5.34711 | -0.709522 | 49.8179 | -181.299 |
| 29 | 5.37064 | -0.68396 | 50.2857 | -184.972 |
| 30 | 5.3845 | -0.655726 | 50.7157 | -188.503 |
| 31 | 5.3845 | -0.631062 | 51.114 | -191.901 |
| 32 | 5.38907 | -0.603765 | 51.4785 | -195.154 |
| 33 | 5.39816 | -0.576911 | 51.8113 | -198.269 |
| 34 | 6.03309 | -0.553384 | 52.1175 | -201.607 |
| 35 | 6.1334 | -0.52728 | 52.3956 | -204.841 |
| 36 | 6.16961 | -0.504372 | 52.65 | -207.953 |
| 37 | 6.17379 | -0.478914 | 52.8793 | -210.91 |
| 38 | 6.18826 | -0.456542 | 53.0877 | -213.735 |
| 39 | 6.19644 | -0.431644 | 53.2741 | -216.41 |
| 40 | 6.25383 | -0.409735 | 53.4419 | -218.972 |
| 41 | 6.25575 | -0.385321 | 53.5904 | -221.383 |
| 42 | 6.2672 | -0.363809 | 53.7228 | -223.663 |
| 43 | 6.27288 | -0.33981 | 53.8382 | -225.794 |
| 44 | 6.27852 | -0.316004 | 53.9381 | -227.778 |
| 45 | 6.28413 | -0.294992 | 54.0251 | -229.632 |
| 46 | 6.28786 | -0.271509 | 54.0988 | -231.339 |
| 47 | 6.28786 | -0.250759 | 54.1617 | -232.916 |
| 48 | 6.28972 | -0.227545 | 54.2135 | -234.347 |
| 49 | 6.30262 | -0.207012 | 54.2564 | -235.652 |
| 50 | 6.30262 | -0.184017 | 54.2902 | -236.812 |
| 51 | 6.30445 | -0.163659 | 54.317 | -237.843 |
| 52 | 6.30628 | -0.140835 | 54.3368 | -238.732 |
| 53 | 6.3081 | -0.12061 | 54.3514 | -239.492 |
| 54 | 6.32436 | -0.0979139 | 54.361 | -240.112 |
| 55 | 6.34564 | -0.0752698 | 54.3666 | -240.589 |
| 56 | 6.34739 | -0.0551734 | 54.3697 | -240.94 |
| 57 | 6.35611 | -0.0325917 | 54.3707 | -241.147 |
| 58 | 6.36819 | -0.0125328 | 54.3709 | -241.227 |
| 59 | 6.37332 | 0.0125328 | 54.3711 | -241.147 |
| 60 | 6.37673 | 0.0325917 | 54.3721 | -240.939 |
| 61 | 6.40192 | 0.0551734 | 54.3752 | -240.586 |
| 62 | 6.41017 | 0.0752698 | 54.3808 | -240.103 |
| 63 | 6.41017 | 0.0979139 | 54.3904 | -239.475 |
| 64 | 6.41673 | 0.12061 | 54.405 | -238.702 |
| 65 | 6.41999 | 0.140835 | 54.4248 | -237.797 |

**Shapiro-Francia Test of Normality (Continued)**
Parameter: Conductivity
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 116

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 615 | 0.163659 | 54.4516 | -10030.1 |
| 67 | 617 | 0.184017 | 54.4854 | -9916.6 |
| 68 | 618 | 0.207012 | 54.5283 | -9788.66 |
| 69 | 619 | 0.227545 | 54.5801 | -9647.81 |
| 70 | 627 | 0.250759 | 54.643 | -9490.59 |
| 71 | 632 | 0.271509 | 54.7167 | -9318.99 |
| 72 | 652 | 0.294992 | 54.8037 | -9126.66 |
| 73 | 657 | 0.316004 | 54.9036 | -8919.04 |
| 74 | 665 | 0.33981 | 55.019 | -8693.07 |
| 75 | 668 | 0.363809 | 55.1514 | -8450.04 |
| 76 | 671 | 0.385321 | 55.2999 | -8191.49 |
| 77 | 675 | 0.409735 | 55.4677 | -7914.92 |
| 78 | 677 | 0.431644 | 55.6541 | -7622.7 |
| 79 | 682 | 0.456542 | 55.8625 | -7311.34 |
| 80 | 683 | 0.478914 | 56.0918 | -6984.24 |
| 81 | 688 | 0.504372 | 56.3462 | -6637.23 |
| 82 | 690 | 0.52728 | 56.6243 | -6273.41 |
| 83 | 691 | 0.553384 | 56.9305 | -5891.02 |
| 84 | 700 | 0.576911 | 57.2633 | -5487.18 |
| 85 | 702 | 0.603765 | 57.6278 | -5063.34 |
| 86 | 712 | 0.631062 | 58.0261 | -4614.02 |
| 87 | 718 | 0.655726 | 58.4561 | -4143.21 |
| 88 | 718 | 0.68396 | 58.9239 | -3652.13 |
| 89 | 719 | 0.709522 | 59.4273 | -3141.98 |
| 90 | 735 | 0.738846 | 59.9732 | -2598.93 |
| 91 | 735 | 0.765456 | 60.5591 | -2036.32 |
| 92 | 739 | 0.796056 | 61.1928 | -1448.04 |
| 93 | 745 | 0.823893 | 61.8716 | -834.236 |
| 94 | 746 | 0.855996 | 62.6043 | -195.663 |
| 95 | 749 | 0.885291 | 63.3881 | 467.42 |
| 96 | 750 | 0.919183 | 64.233 | 1156.81 |
| 97 | 750 | 0.954165 | 65.1434 | 1872.43 |
| 98 | 750 | 0.986272 | 66.1161 | 2612.13 |
| 99 | 752 | 1.02365 | 67.164 | 3381.92 |
| 100 | 760 | 1.05812 | 68.2836 | 4186.09 |
| 101 | 767 | 1.09847 | 69.4903 | 5028.62 |
| 102 | 771 | 1.1359 | 70.7805 | 5904.4 |
| 103 | 777 | 1.18 | 72.1729 | 6821.26 |
| 104 | 783 | 1.22123 | 73.6643 | 7777.48 |
| 105 | 786 | 1.27024 | 75.2778 | 8775.88 |
| 106 | 789 | 1.31652 | 77.011 | 9814.62 |
| 107 | 806 | 1.3722 | 78.894 | 10920.6 |
| 108 | 810 | 1.4325 | 80.9461 | 12080.9 |
| 109 | 816 | 1.49085 | 83.1687 | 13297.5 |
| 110 | 834 | 1.56322 | 85.6124 | 14601.2 |
| 111 | 849 | 1.63524 | 88.2864 | 15989.5 |
| 112 | 853 | 1.72793 | 91.2721 | 17463.4 |
| 113 | 855 | 1.82501 | 94.6027 | 19023.8 |
| 114 | 857 | 1.95996 | 98.4442 | 20703.5 |
| 115 | 876 | 2.12007 | 102.939 | 22560.7 |
| 116 | 880 | 2.40892 | 108.742 | 24680.5 |

Data Set Standard Deviation = 233.335
Numerator = 6.09129e+008
Denominator = 6.80855e+008
W Statistic = 0.894653 = 6.09129e+008 / 6.80855e+008

5% Critical value of 0.976 exceeds 0.894653
Evidence of non-normality at 95% level of significance

**Shapiro-Francia Test of Normality**
**Parameter: Conductivity**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 58 | -2.40892 | 5.80292 | -139.718 |
| 2 | 108 | -2.12007 | 10.2976 | -368.685 |
| 3 | 160 | -1.95996 | 14.1391 | -682.279 |
| 4 | 183 | -1.82501 | 17.4697 | -1016.25 |
| 5 | 183 | -1.72793 | 20.4554 | -1332.47 |
| 6 | 185 | -1.63524 | 23.1294 | -1634.98 |
| 7 | 185 | -1.56322 | 25.5731 | -1924.18 |
| 8 | 186 | -1.49085 | 27.7957 | -2201.48 |
| 9 | 187 | -1.4325 | 29.8478 | -2469.36 |
| 10 | 191 | -1.3722 | 31.7308 | -2731.45 |
| 11 | 193 | -1.31652 | 33.464 | -2985.54 |
| 12 | 195 | -1.27024 | 35.0775 | -3233.23 |
| 13 | 195 | -1.22123 | 36.5689 | -3471.37 |
| 14 | 195 | -1.18 | 37.9613 | -3701.47 |
| 15 | 196 | -1.1359 | 39.2515 | -3924.11 |
| 16 | 197 | -1.09847 | 40.4582 | -4140.51 |
| 17 | 198 | -1.05812 | 41.5778 | -4350.02 |
| 18 | 198 | -1.02365 | 42.6257 | -4552.7 |
| 19 | 199 | -0.986272 | 43.5984 | -4748.97 |
| 20 | 199 | -0.954165 | 44.5088 | -4938.85 |
| 21 | 200 | -0.919183 | 45.3537 | -5122.68 |
| 22 | 201 | -0.885291 | 46.1375 | -5300.63 |
| 23 | 205 | -0.855996 | 46.8702 | -5476.1 |
| 24 | 205 | -0.823893 | 47.549 | -5645 |
| 25 | 207 | -0.796056 | 48.1827 | -5809.79 |
| 26 | 208 | -0.765456 | 48.7686 | -5969 |
| 27 | 209 | -0.738846 | 49.3145 | -6123.42 |
| 28 | 210 | -0.709522 | 49.8179 | -6272.42 |
| 29 | 215 | -0.68396 | 50.2857 | -6419.47 |
| 30 | 218 | -0.655726 | 50.7157 | -6562.42 |
| 31 | 218 | -0.631062 | 51.114 | -6699.99 |
| 32 | 219 | -0.603765 | 51.4785 | -6832.22 |
| 33 | 221 | -0.576911 | 51.8113 | -6959.71 |
| 34 | 417 | -0.553384 | 52.1175 | -7190.47 |
| 35 | 461 | -0.52728 | 52.3956 | -7433.55 |
| 36 | 478 | -0.504372 | 52.65 | -7674.64 |
| 37 | 480 | -0.478914 | 52.8793 | -7904.52 |
| 38 | 487 | -0.456542 | 53.0877 | -8126.85 |
| 39 | 491 | -0.431644 | 53.2741 | -8338.79 |
| 40 | 520 | -0.409735 | 53.4419 | -8551.85 |
| 41 | 521 | -0.385321 | 53.5904 | -8752.61 |
| 42 | 527 | -0.363809 | 53.7228 | -8944.33 |
| 43 | 530 | -0.33981 | 53.8382 | -9124.43 |
| 44 | 533 | -0.316004 | 53.9381 | -9292.86 |
| 45 | 536 | -0.294992 | 54.0251 | -9450.98 |
| 46 | 538 | -0.271509 | 54.0988 | -9597.05 |
| 47 | 538 | -0.250759 | 54.1617 | -9731.96 |
| 48 | 539 | -0.227545 | 54.2135 | -9854.61 |
| 49 | 546 | -0.207012 | 54.2564 | -9967.63 |
| 50 | 546 | -0.184017 | 54.2902 | -10068.1 |
| 51 | 547 | -0.163659 | 54.317 | -10157.6 |
| 52 | 548 | -0.140835 | 54.3368 | -10234.8 |
| 53 | 549 | -0.12061 | 54.3514 | -10301 |
| 54 | 558 | -0.0979139 | 54.361 | -10355.7 |
| 55 | 570 | -0.0752698 | 54.3666 | -10398.6 |
| 56 | 571 | -0.0551734 | 54.3697 | -10430.1 |
| 57 | 576 | -0.0325917 | 54.3707 | -10448.8 |
| 58 | 583 | -0.0125328 | 54.3709 | -10456.1 |
| 59 | 586 | 0.0125328 | 54.3711 | -10448.8 |
| 60 | 588 | 0.0325917 | 54.3721 | -10429.6 |
| 61 | 603 | 0.0551734 | 54.3752 | -10396.4 |
| 62 | 608 | 0.0752698 | 54.3808 | -10350.6 |
| 63 | 608 | 0.0979139 | 54.3904 | -10291.1 |
| 64 | 612 | 0.12061 | 54.405 | -10217.3 |
| 65 | 614 | 0.140835 | 54.4248 | -10130.8 |

**Rosner's Test for Outliers (Continued)**
**Parameter: Conductivity**
**Background Locations**
**Original Data (Not Transformed)**

---

Iteration i = 3
Mean of 113 measurements = 538.283
Std Dev = 225.923
x(i+1) = 880 from measurement 4/3/2002 from location B-50
Rosner Statistic R = |880 - 538.283|/225.923 = 1.51254
Lambda(116, 4, 0.05) = 3.4148
1.51254 < 3.4148 -- No outliers detected for i = 3

---

Iteration i = 2
Mean of 114 measurements = 534.965
Std Dev = 227.694
x(i+1) = 160 from measurement 1/4/2007 from location B-51
Rosner Statistic R = |160 - 534.965|/227.694 = 1.64679
Lambda(116, 3, 0.05) = 3.4216
1.64679 < 3.4216 -- No outliers detected for i = 2

---

Iteration i = 1
Mean of 115 measurements = 531.252
Std Dev = 230.163
x(i+1) = 108 from measurement 4/2/2003 from location B-50
Rosner Statistic R = |108 - 531.252|/230.163 = 1.83892
Lambda(116, 2, 0.05) = 3.4216
1.83892 < 3.4216 -- No outliers detected for i = 1

---

Iteration i = 0
Mean of 116 measurements = 527.172
Std Dev = 233.335
x(i+1) = 58 from measurement 10/2/2003 from location B-51
Rosner Statistic R = |58 - 527.172|/233.335 = 2.01072
Lambda(116, 1, 0.05) = 3.4248
2.01072 < 3.4248 -- No outliers detected for i = 0

**NO OUTLIERS DETECTED**

**Rosner's Test for Outliers**
**Parameter: Conductivity**
**Background Locations**
**Original Data (Not Transformed)**

Data set mean = 527.172

10 most extreme of 116 measurements
by order of magnitude difference from the mean

| | | | | |
|---|---|---|---|---|
| 1 | 10/2/2003 | B-51 | 58 | -469.172 |
| 2 | 4/2/2003 | B-50 | 108 | -419.172 |
| 3 | 1/4/2007 | B-51 | 160 | -367.172 |
| 4 | 4/3/2002 | B-50 | 880 | 352.828 |
| 5 | 10/13/2005 | B-52 | 876 | 348.828 |
| 6 | 8/16/2011 | B-51 | 183 | -344.172 |
| 7 | 4/6/2005 | B-51 | 183 | 344.172 |
| 8 | 4/2/2003 | B-51 | 185 | -342.172 |
| 9 | 4/4/2007 | B-51 | 185 | -342.172 |
| 10 | 1/7/2010 | B-51 | 186 | -341.172 |

--------------------------------------------
Iteration i = 9
Mean of 107 measurements = 545.178
Std Dev = 216.722
x(i+1) = 186 from measurement 1/7/2010 from location B-51
Rosner Statistic R = |186 - 545.178|/216.722 = 1.65732
Lambda(116, 10, 0.05) = 3.398
1.65732 < 3.398 -- No outliers detected for i = 9

--------------------------------------------
Iteration i = 8
Mean of 108 measurements = 541.843
Std Dev = 218.473
x(i+1) = 185 from measurement 4/4/2007 from location B-51
Rosner Statistic R = |185 - 541.843|/218.473 = 1.63335
Lambda(116, 9, 0.05) = 3.40136
1.63335 < 3.40136 -- No outliers detected for i = 8

--------------------------------------------
Iteration i = 7
Mean of 109 measurements = 538.569
Std Dev = 220.129
x(i+1) = 185 from measurement 4/2/2003 from location B-51
Rosner Statistic R = |185 - 538.569|/220.129 = 1.60619
Lambda(116, 8, 0.05) = 3.40472
1.60619 < 3.40472 -- No outliers detected for i = 7

--------------------------------------------
Iteration i = 6
Mean of 110 measurements = 535.336
Std Dev = 221.724
x(i+1) = 183 from measurement 4/6/2005 from location B-51
Rosner Statistic R = |183 - 535.336|/221.724 = 1.58908
Lambda(116, 7, 0.05) = 3.40808
1.58908 < 3.40808 -- No outliers detected for i = 6

--------------------------------------------
Iteration i = 5
Mean of 111 measurements = 532.162
Std Dev = 223.233
x(i+1) = 183 from measurement 8/16/2011 from location B-51
Rosner Statistic R = |183 - 532.162|/223.233 = 1.56411
Lambda(116, 6, 0.05) = 3.41144
1.56411 < 3.41144 -- No outliers detected for i = 5

--------------------------------------------
Iteration i = 4
Mean of 112 measurements = 535.232
Std Dev = 224.588
x(i+1) = 876 from measurement 10/13/2005 from location B-52
Rosner Statistic R = |876 - 535.232|/224.588 = 1.5173
Lambda(116, 5, 0.05) = 3.4148
1.5173 < 3.4148 -- No outliers detected for i = 4

**Concentrations (umhos) - Continued**
**Parameter: Conductivity**
**Original Data (Not Transformed)**
**Percent Background Non-Detects: 0%**
**Total Background Measurements: 116**
**There are 3 background locations**

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| | | | 10/22/2008 | 195 | 195 |
| | | | 1/13/2009 | 195 | 195 |
| | | | 4/8/2009 | 191 | 191 |
| | | | 7/15/2009 | 198 | 198 |
| | | | 1/7/2010 | 186 | 186 |
| | | | 4/7/2010 | 198 | 198 |
| | | | 7/7/2010 | 208 | 208 |
| | | | 8/16/2011 | 183 | 183 |
| | | | 10/26/2011 | 197 | 197 |
| B-50 | 42 | 0 (0%) | 11/15/2001 | 816 | 816 |
| | | | 1/16/2002 | 857 | 857 |
| | | | 4/3/2002 | 880 | 880 |
| | | | 7/2/2002 | 735 | 735 |
| | | | 10/2/2002 | 810 | 810 |
| | | | 1/8/2003 | 849 | 849 |
| | | | 4/2/2003 | 108 | 108 |
| | | | 7/23/2003 | 806 | 806 |
| | | | 10/2/2003 | 750 | 750 |
| | | | 1/7/2004 | 834 | 834 |
| | | | 4/7/2004 | 783 | 783 |
| | | | 7/13/2004 | 855 | 855 |
| | | | 10/6/2004 | 767 | 767 |
| | | | 1/6/2005 | 760 | 760 |
| | | | 4/6/2005 | 786 | 786 |
| | | | 7/27/2005 | 750 | 750 |
| | | | 10/13/2005 | 789 | 789 |
| | | | 1/5/2006 | 752 | 752 |
| | | | 4/6/2006 | 749 | 749 |
| | | | 7/25/2006 | 735 | 735 |
| | | | 10/11/2006 | 750 | 750 |
| | | | 1/4/2007 | 777 | 777 |
| | | | 4/4/2007 | 746 | 746 |
| | | | 7/12/2007 | 718 | 718 |
| | | | 10/10/2007 | 718 | 718 |
| | | | 1/16/2008 | 677 | 677 |
| | | | 4/3/2008 | 691 | 691 |
| | | | 7/23/2008 | 668 | 668 |
| | | | 10/22/2008 | 683 | 683 |
| | | | 1/13/2009 | 671 | 671 |
| | | | 4/8/2009 | 688 | 688 |
| | | | 7/15/2009 | 617 | 617 |
| | | | 10/8/2009 | 608 | 608 |
| | | | 1/7/2010 | 682 | 682 |
| | | | 4/7/2010 | 700 | 700 |
| | | | 7/7/2010 | 652 | 652 |
| | | | 12/8/2010 | 619 | 619 |
| | | | 2/3/2011 | 586 | 586 |
| | | | 4/13/2011 | 614 | 614 |
| | | | 8/16/2011 | 608 | 608 |
| | | | 10/26/2011 | 618 | 618 |
| | | | 1/18/2012 | 612 | 612 |

**Concentrations (umhos)**
**Parameter: Conductivity**
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-52 | 42 | 0 (0%) | 11/15/2001 | 461 | 461 |
| | | | 1/16/2002 | 570 | 570 |
| | | | 4/3/2002 | 615 | 615 |
| | | | 7/2/2002 | 480 | 480 |
| | | | 10/2/2002 | 547 | 547 |
| | | | 1/8/2003 | 627 | 627 |
| | | | 4/2/2003 | 417 | 417 |
| | | | 7/23/2003 | 487 | 487 |
| | | | 10/2/2003 | 771 | 771 |
| | | | 1/7/2004 | 530 | 530 |
| | | | 4/7/2004 | 739 | 739 |
| | | | 7/13/2004 | 533 | 533 |
| | | | 10/6/2004 | 536 | 536 |
| | | | 1/6/2005 | 745 | 745 |
| | | | 4/6/2005 | 538 | 538 |
| | | | 7/27/2005 | 520 | 520 |
| | | | 10/13/2005 | 876 | 876 |
| | | | 1/5/2006 | 558 | 558 |
| | | | 4/6/2006 | 546 | 546 |
| | | | 7/25/2006 | 588 | 588 |
| | | | 10/11/2006 | 853 | 853 |
| | | | 1/4/2007 | 712 | 712 |
| | | | 4/4/2007 | 576 | 576 |
| | | | 7/12/2007 | 478 | 478 |
| | | | 10/10/2007 | 632 | 632 |
| | | | 1/16/2008 | 549 | 549 |
| | | | 4/3/2008 | 571 | 571 |
| | | | 7/23/2008 | 538 | 538 |
| | | | 10/22/2008 | 527 | 527 |
| | | | 1/13/2009 | 548 | 548 |
| | | | 4/8/2009 | 546 | 546 |
| | | | 7/15/2009 | 690 | 690 |
| | | | 10/8/2009 | 491 | 491 |
| | | | 1/7/2010 | 665 | 665 |
| | | | 4/7/2010 | 719 | 719 |
| | | | 7/7/2010 | 521 | 521 |
| | | | 12/8/2010 | 539 | 539 |
| | | | 2/3/2011 | 583 | 583 |
| | | | 4/13/2011 | 603 | 603 |
| | | | 8/16/2011 | 675 | 675 |
| | | | 10/26/2011 | 657 | 657 |
| | | | 1/18/2012 | 702 | 702 |
| B-51 | 32 | 0 (0%) | 11/15/2001 | 205 | 205 |
| | | | 10/2/2002 | 200 | 200 |
| | | | 1/8/2003 | 219 | 219 |
| | | | 4/2/2003 | 185 | 185 |
| | | | 7/23/2003 | 209 | 209 |
| | | | 10/2/2003 | 58 | 58 |
| | | | 1/7/2004 | 193 | 193 |
| | | | 4/7/2004 | 195 | 195 |
| | | | 7/13/2004 | 218 | 218 |
| | | | 10/6/2004 | 199 | 199 |
| | | | 1/6/2005 | 207 | 207 |
| | | | 4/6/2005 | 183 | 183 |
| | | | 7/27/2005 | 218 | 218 |
| | | | 10/13/2005 | 221 | 221 |
| | | | 1/5/2006 | 201 | 201 |
| | | | 4/6/2006 | 215 | 215 |
| | | | 7/25/2006 | 199 | 199 |
| | | | 10/11/2006 | 205 | 205 |
| | | | 1/4/2007 | 160 | 160 |
| | | | 4/4/2007 | 185 | 185 |
| | | | 7/12/2007 | 187 | 187 |
| | | | 10/10/2007 | 196 | 196 |
| | | | 7/23/2008 | 210 | 210 |

**Non-Parametric Prediction Interval**
**Inter-Well Comparison**
**Parameter: Total Hardness**
**Original Data (Not Transformed)**

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
**Maximum Background Value = 453**
Confidence Level = 99%
False Positive Rate = 1%

| Location | Date | Count | Mean | Significant |
|---|---|---|---|---|
| B-30A | 4/4/2012 | 1 | 133.38 | FALSE |
| B-32 | 4/4/2012 | 1 | 418.95 | FALSE |
| B-31 | 4/4/2012 | 1 | 10.26 | FALSE |
| DM-1 | 4/4/2012 | 1 | 201.78 | FALSE |
| DM-7 | 4/4/2012 | 1 | 13.68 | FALSE |
| DM-6 | 4/4/2012 | 1 | 3.42 | FALSE |
| DM-5 | 4/4/2012 | 1 | 367.65 | FALSE |

**Shapiro-Francia Test of Normality (Continued)**
**Parameter: Total Hardness**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Natural Logarithm Transformation**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 5.63636 | 0.163659 | 54.4516 | -177.3 |
| 67 | 5.63636 | 0.184017 | 54.4854 | -176.263 |
| 68 | 5.63636 | 0.207012 | 54.5283 | -175.096 |
| 69 | 5.64848 | 0.227545 | 54.5801 | -173.81 |
| 70 | 5.66046 | 0.250759 | 54.643 | -172.391 |
| 71 | 5.66046 | 0.271509 | 54.7167 | -170.854 |
| 72 | 5.66046 | 0.294992 | 54.8037 | -169.184 |
| 73 | 5.67229 | 0.316004 | 54.9036 | -167.392 |
| 74 | 5.67229 | 0.33981 | 55.019 | -165.464 |
| 75 | 5.67229 | 0.363809 | 55.1514 | -163.401 |
| 76 | 5.67229 | 0.385321 | 55.2999 | -161.215 |
| 77 | 5.67229 | 0.409735 | 55.4677 | -158.891 |
| 78 | 5.67229 | 0.431644 | 55.6541 | -156.443 |
| 79 | 5.68399 | 0.456542 | 55.8625 | -153.848 |
| 80 | 5.69555 | 0.478914 | 56.0918 | -151.12 |
| 81 | 5.70128 | 0.504372 | 56.3462 | -148.244 |
| 82 | 5.70698 | 0.52728 | 56.6243 | -145.235 |
| 83 | 5.72945 | 0.553384 | 56.9305 | -142.065 |
| 84 | 5.72945 | 0.576911 | 57.2633 | -138.759 |
| 85 | 5.75143 | 0.603765 | 57.6278 | -135.287 |
| 86 | 5.75143 | 0.631062 | 58.0261 | -131.657 |
| 87 | 5.76224 | 0.655726 | 58.4561 | -127.879 |
| 88 | 5.77294 | 0.68396 | 58.9239 | -123.93 |
| 89 | 5.78352 | 0.709522 | 59.4273 | -119.827 |
| 90 | 5.79399 | 0.738846 | 59.9732 | -115.546 |
| 91 | 5.79399 | 0.765456 | 60.5591 | -111.111 |
| 92 | 5.81461 | 0.796056 | 61.1928 | -106.482 |
| 93 | 5.82476 | 0.823893 | 61.8716 | -101.683 |
| 94 | 5.83481 | 0.855996 | 62.6043 | -96.6885 |
| 95 | 5.83481 | 0.885291 | 63.3881 | -91.523 |
| 96 | 5.83481 | 0.919183 | 64.233 | -86.1597 |
| 97 | 5.83481 | 0.954165 | 65.1434 | -80.5924 |
| 98 | 5.83481 | 0.986272 | 66.1161 | -74.8377 |
| 99 | 5.83481 | 1.02365 | 67.164 | -68.8648 |
| 100 | 5.83481 | 1.05812 | 68.2836 | -62.6909 |
| 101 | 5.83481 | 1.09847 | 69.4903 | -56.2815 |
| 102 | 5.83481 | 1.1359 | 70.7805 | -49.6538 |
| 103 | 5.83481 | 1.18 | 72.1729 | -42.7687 |
| 104 | 5.83481 | 1.22123 | 73.6643 | -35.6431 |
| 105 | 5.84476 | 1.27024 | 75.2778 | -28.2189 |
| 106 | 5.8595 | 1.31652 | 77.011 | -20.5047 |
| 107 | 5.8595 | 1.3722 | 78.894 | -12.4643 |
| 108 | 5.89779 | 1.4325 | 80.9461 | -4.01566 |
| 109 | 5.90247 | 1.49085 | 83.1687 | 4.78405 |
| 110 | 5.91177 | 1.56322 | 85.6124 | 14.0255 |
| 111 | 5.92557 | 1.63524 | 88.2864 | 23.7152 |
| 112 | 5.93012 | 1.72793 | 91.2721 | 33.962 |
| 113 | 5.95259 | 1.82501 | 94.6027 | 44.8255 |
| 114 | 6.01713 | 1.95996 | 98.4442 | 56.6189 |
| 115 | 6.07776 | 2.12007 | 102.939 | 69.5041 |
| 116 | 6.11589 | 2.40892 | 108.742 | 84.2368 |

Data Set Standard Deviation = 0.861824
Numerator = 7095.84
Denominator = 9288.2
W Statistic = 0.763964 = 7095.84 / 9288.2

5% Critical value of 0.976 exceeds 0.763964
Evidence of non-normality at 95% level of significance

**Shapiro-Francia Test of Normality**
**Parameter: Total Hardness**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Natural Logarithm Transformation**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 3.48093 | -2.40892 | 5.80292 | -8.3853 |
| 2 | 3.48093 | -2.12007 | 10.2976 | -15.7651 |
| 3 | 3.53223 | -1.95996 | 14.1391 | -22.6881 |
| 4 | 3.53223 | -1.82501 | 17.4697 | -29.1345 |
| 5 | 3.58102 | -1.72793 | 20.4554 | -35.3222 |
| 6 | 3.58102 | -1.63524 | 23.1294 | -41.178 |
| 7 | 3.58102 | -1.56322 | 25.5731 | -46.7759 |
| 8 | 3.62754 | -1.49085 | 27.7957 | -52.1841 |
| 9 | 3.62754 | -1.4325 | 29.8478 | -57.3805 |
| 10 | 3.67199 | 1.3722 | 31.7308 | -62.4192 |
| 11 | 3.67199 | -1.31652 | 33.464 | -67.2535 |
| 12 | 3.67199 | -1.27024 | 35.0775 | -71.9178 |
| 13 | 3.71455 | -1.22123 | 36.5689 | -76.4541 |
| 14 | 3.71455 | -1.18 | 37.9613 | -80.8373 |
| 15 | 3.75537 | -1.1359 | 39.2515 | -85.103 |
| 16 | 3.75537 | -1.09847 | 40.4582 | -89.2281 |
| 17 | 3.75537 | -1.05812 | 41.5778 | -93.2018 |
| 18 | 3.79459 | -1.02365 | 42.6257 | -97.0861 |
| 19 | 3.79459 | -0.986272 | 43.5984 | -100.829 |
| 20 | 3.83233 | -0.954165 | 44.5088 | -104.485 |
| 21 | 3.83233 | -0.919183 | 45.3537 | -108.008 |
| 22 | 3.83233 | -0.885291 | 46.1375 | -111.401 |
| 23 | 3.8687 | -0.855996 | 46.8702 | -114.712 |
| 24 | 3.8687 | -0.823893 | 47.549 | -117.9 |
| 25 | 3.90379 | -0.796056 | 48.1827 | -121.007 |
| 26 | 3.90379 | -0.765456 | 48.7686 | -123.995 |
| 27 | 4.00223 | 0.738846 | 49.3145 | -126.952 |
| 28 | 4.09184 | -0.709522 | 49.8179 | -129.856 |
| 29 | 4.12001 | -0.68396 | 50.2857 | -132.674 |
| 30 | 4.22537 | -0.655726 | 50.7157 | -135.444 |
| 31 | 4.27416 | -0.631062 | 51.114 | -138.142 |
| 32 | 4.85398 | -0.603765 | 51.4785 | -141.072 |
| 33 | 5.10084 | -0.576911 | 51.8113 | -144.015 |
| 34 | 5.25499 | -0.553384 | 52.1175 | -146.923 |
| 35 | 5.28137 | -0.52728 | 52.3956 | -149.708 |
| 36 | 5.29867 | -0.504372 | 52.65 | -152.38 |
| 37 | 5.34568 | -0.478914 | 52.8793 | -154.94 |
| 38 | 5.35677 | -0.456542 | 53.0877 | -157.386 |
| 39 | 5.35677 | -0.431644 | 53.2741 | -159.698 |
| 40 | 5.36481 | -0.409735 | 53.4419 | -161.896 |
| 41 | 5.38852 | -0.385321 | 53.5904 | -163.973 |
| 42 | 5.38852 | -0.363809 | 53.7228 | -165.933 |
| 43 | 5.39631 | -0.33981 | 53.8382 | -167.767 |
| 44 | 5.43433 | -0.316004 | 53.9381 | -169.484 |
| 45 | 5.44915 | -0.294992 | 54.0251 | -171.091 |
| 46 | 5.44915 | -0.271509 | 54.0988 | -172.571 |
| 47 | 5.47814 | -0.250759 | 54.1617 | -173.945 |
| 48 | 5.47814 | -0.227545 | 54.2135 | -175.191 |
| 49 | 5.51323 | -0.207012 | 54.2564 | -176.333 |
| 50 | 5.5201 | -0.184017 | 54.2902 | -177.348 |
| 51 | 5.53371 | -0.163659 | 54.317 | -178.254 |
| 52 | 5.54713 | -0.140835 | 54.3368 | -179.035 |
| 53 | 5.54713 | -0.12061 | 54.3514 | -179.704 |
| 54 | 5.54713 | -0.0979139 | 54.361 | -180.247 |
| 55 | 5.56037 | 0.0752698 | 54.3666 | -180.666 |
| 56 | 5.57348 | -0.0551734 | 54.3697 | -180.973 |
| 57 | 5.58635 | -0.0325917 | 54.3707 | -181.155 |
| 58 | 5.59274 | 0.0125328 | 54.3709 | -181.226 |
| 59 | 5.59909 | 0.0125328 | 54.3711 | -181.155 |
| 60 | 5.61167 | 0.0325917 | 54.3721 | -180.972 |
| 61 | 5.61167 | 0.0551734 | 54.3752 | -180.663 |
| 62 | 5.61167 | 0.0752698 | 54.3808 | -180.24 |
| 63 | 5.61167 | 0.0979139 | 54.3904 | -179.691 |
| 64 | 5.61167 | 0.12061 | 54.405 | -179.014 |
| 65 | 5.62409 | 0.140835 | 54.4248 | -178.222 |

**Shapiro-Francia Test of Normality (Continued)**
**Parameter: Total Hardness**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 280.44 | 0.163659 | 54.4516 | -3049.22 |
| 67 | 280.44 | 0.184017 | 54.4854 | -2997.62 |
| 68 | 280.44 | 0.207012 | 54.5283 | -2939.56 |
| 69 | 283.86 | 0.227545 | 54.5801 | -2874.97 |
| 70 | 287.28 | 0.250759 | 54.643 | -2802.93 |
| 71 | 287.28 | 0.271509 | 54.7167 | -2724.94 |
| 72 | 287.28 | 0.294992 | 54.8037 | -2640.19 |
| 73 | 290.7 | 0.316004 | 54.9036 | -2548.33 |
| 74 | 290.7 | 0.33981 | 55.019 | -2449.55 |
| 75 | 290.7 | 0.363809 | 55.1514 | -2343.79 |
| 76 | 290.7 | 0.385321 | 55.2999 | -2231.77 |
| 77 | 290.7 | 0.409735 | 55.4677 | -2112.66 |
| 78 | 290.7 | 0.431644 | 55.6541 | -1987.18 |
| 79 | 294.12 | 0.456542 | 55.8625 | -1852.91 |
| 80 | 297.54 | 0.478914 | 56.0918 | -1710.41 |
| 81 | 299.25 | 0.504372 | 56.3462 | -1559.48 |
| 82 | 300.96 | 0.52728 | 56.6243 | -1400.79 |
| 83 | 307.8 | 0.553384 | 56.9305 | -1230.45 |
| 84 | 307.8 | 0.576911 | 57.2633 | -1052.88 |
| 85 | 314.64 | 0.603765 | 57.6278 | -862.913 |
| 86 | 314.64 | 0.631062 | 58.0261 | -664.356 |
| 87 | 318.06 | 0.655726 | 58.4561 | -455.796 |
| 88 | 321.48 | 0.68396 | 58.9239 | -235.916 |
| 89 | 324.9 | 0.709522 | 59.4273 | -5.39239 |
| 90 | 328.32 | 0.738846 | 59.9732 | 237.186 |
| 91 | 328.32 | 0.765456 | 60.5591 | 488.5 |
| 92 | 335.16 | 0.796056 | 61.1928 | 755.306 |
| 93 | 338.58 | 0.823893 | 61.8716 | 1034.26 |
| 94 | 342 | 0.855996 | 62.6043 | 1327.01 |
| 95 | 342 | 0.885291 | 63.3881 | 1629.78 |
| 96 | 342 | 0.919183 | 64.233 | 1944.14 |
| 97 | 342 | 0.954165 | 65.1434 | 2270.46 |
| 98 | 342 | 0.986272 | 66.1161 | 2607.77 |
| 99 | 342 | 1.02365 | 67.164 | 2957.86 |
| 100 | 342 | 1.05812 | 68.2836 | 3319.74 |
| 101 | 342 | 1.09847 | 69.4903 | 3695.41 |
| 102 | 342 | 1.1359 | 70.7805 | 4083.89 |
| 103 | 342 | 1.18 | 72.1729 | 4487.45 |
| 104 | 342 | 1.22123 | 73.6643 | 4905.11 |
| 105 | 345.42 | 1.27024 | 75.2778 | 5343.87 |
| 106 | 350.55 | 1.31652 | 77.011 | 5805.38 |
| 107 | 350.55 | 1.3722 | 78.894 | 6286.41 |
| 108 | 364.23 | 1.4325 | 80.9461 | 6808.17 |
| 109 | 365.94 | 1.49085 | 83.1687 | 7353.73 |
| 110 | 369.36 | 1.56322 | 85.6124 | 7931.12 |
| 111 | 374.49 | 1.63524 | 88.2864 | 8543.5 |
| 112 | 376.2 | 1.72793 | 91.2721 | 9193.55 |
| 113 | 384.75 | 1.82501 | 94.6027 | 9895.72 |
| 114 | 410.4 | 1.95996 | 98.4442 | 10700.1 |
| 115 | 436.05 | 2.12007 | 102.939 | 11624.5 |
| 116 | 453 | 2.40892 | 108.742 | 12715.8 |

Data Set Standard Deviation = 121.228
Numerator = 1.61691e+008
Denominator = 1.83782e+008
W Statistic = 0.879798 = 1.61691e+008 / 1.83782e+008

5% Critical value of 0.976 exceeds 0.879798
Evidence of non-normality at 95% level of significance

**Shapiro-Francia Test of Normality**
**Parameter: Total Hardness**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 32.49 | -2.40892 | 5.80292 | -78.2659 |
| 2 | 32.49 | -2.12007 | 10.2976 | -147.147 |
| 3 | 34.2 | -1.95996 | 14.1391 | -214.178 |
| 4 | 34.2 | -1.82501 | 17.4697 | -276.593 |
| 5 | 35.91 | -1.72793 | 20.4554 | -338.643 |
| 6 | 35.91 | -1.63524 | 23.1294 | -397.364 |
| 7 | 35.91 | -1.56322 | 25.5731 | -453.499 |
| 8 | 37.62 | -1.49085 | 27.7957 | -509.585 |
| 9 | 37.62 | -1.4325 | 29.8478 | -563.476 |
| 10 | 39.33 | -1.3722 | 31.7308 | -617.445 |
| 11 | 39.33 | -1.31652 | 33.464 | -669.224 |
| 12 | 39.33 | -1.27024 | 35.0775 | -719.182 |
| 13 | 41.04 | -1.22123 | 36.5689 | -769.301 |
| 14 | 41.04 | -1.18 | 37.9613 | -817.729 |
| 15 | 42.75 | -1.1359 | 39.2515 | -866.288 |
| 16 | 42.75 | -1.09847 | 40.4582 | -913.248 |
| 17 | 42.75 | -1.05812 | 41.5778 | -958.482 |
| 18 | 44.46 | -1.02365 | 42.6257 | -1003.99 |
| 19 | 44.46 | -0.986272 | 43.5984 | -1047.84 |
| 20 | 46.17 | -0.954165 | 44.5088 | -1091.9 |
| 21 | 46.17 | -0.919183 | 45.3537 | -1134.34 |
| 22 | 46.17 | -0.885291 | 46.1375 | -1175.21 |
| 23 | 47.88 | -0.855996 | 46.8702 | -1216.19 |
| 24 | 47.88 | -0.823893 | 47.549 | -1255.64 |
| 25 | 49.59 | -0.796056 | 48.1827 | -1295.12 |
| 26 | 49.59 | -0.765456 | 48.7686 | -1333.08 |
| 27 | 54.72 | -0.738846 | 49.3145 | -1373.51 |
| 28 | 59.85 | -0.709522 | 49.8179 | -1415.97 |
| 29 | 61.56 | -0.68396 | 50.2857 | -1458.08 |
| 30 | 68.4 | -0.655726 | 50.7157 | -1502.93 |
| 31 | 71.82 | -0.631062 | 51.114 | -1548.25 |
| 32 | 128.25 | -0.603765 | 51.4785 | -1625.68 |
| 33 | 164.16 | -0.576911 | 51.8113 | -1720.39 |
| 34 | 191.52 | -0.553384 | 52.1175 | -1826.37 |
| 35 | 196.64 | -0.52728 | 52.3956 | -1930.06 |
| 36 | 200.07 | -0.504372 | 52.65 | -2030.97 |
| 37 | 209.7 | -0.478914 | 52.8793 | -2131.4 |
| 38 | 212.04 | -0.456542 | 53.0877 | -2228.2 |
| 39 | 212.04 | -0.431644 | 53.2741 | -2319.73 |
| 40 | 213.75 | -0.409735 | 53.4419 | -2407.31 |
| 41 | 218.88 | -0.385321 | 53.5904 | -2491.65 |
| 42 | 218.88 | -0.363809 | 53.7228 | -2571.28 |
| 43 | 220.59 | -0.33981 | 53.8382 | -2646.24 |
| 44 | 229.14 | -0.316004 | 53.9381 | -2718.65 |
| 45 | 232.56 | -0.294992 | 54.0251 | -2787.25 |
| 46 | 232.56 | -0.271509 | 54.0988 | -2850.39 |
| 47 | 239.4 | -0.250759 | 54.1617 | -2910.42 |
| 48 | 239.4 | -0.227545 | 54.2135 | -2964.9 |
| 49 | 247.95 | -0.207012 | 54.2564 | -3016.23 |
| 50 | 249.66 | -0.184017 | 54.2902 | -3062.17 |
| 51 | 253.08 | -0.163659 | 54.317 | -3103.59 |
| 52 | 256.5 | -0.140835 | 54.3368 | -3139.71 |
| 53 | 256.5 | -0.12061 | 54.3514 | -3170.65 |
| 54 | 256.5 | -0.0979139 | 54.361 | -3195.76 |
| 55 | 259.92 | -0.0752698 | 54.3666 | -3215.33 |
| 56 | 263.35 | -0.0551734 | 54.3697 | -3229.86 |
| 57 | 266.76 | -0.0325917 | 54.3707 | -3238.55 |
| 58 | 268.47 | -0.0125328 | 54.3709 | -3241.92 |
| 59 | 270.18 | 0.0125328 | 54.3711 | -3238.53 |
| 60 | 273.6 | 0.0325917 | 54.3721 | -3229.61 |
| 61 | 273.6 | 0.0551734 | 54.3752 | -3214.52 |
| 62 | 273.6 | 0.0752698 | 54.3808 | -3193.92 |
| 63 | 273.6 | 0.0979139 | 54.3904 | -3167.13 |
| 64 | 273.6 | 0.12061 | 54.405 | -3134.14 |
| 65 | 277.02 | 0.140835 | 54.4248 | -3095.12 |

## Rosner's Test for Outliers (Continued)

**Parameter: Total Hardness**

**Background Locations**

**Original Data (Not Transformed)**

--------------------------------------------

Iteration i = 3
Mean of 113 measurements = 224.08
Std Dev = 117.89
x(i+1) = 32.49 from measurement 10/11/2006 from location B-51
Rosner Statistic R = |32.49 - 224.08|/117.89 = 1.62516
Lambda(116, 4, 0.05) = 3.4148
1.62516 < 3.4148 -- No outliers detected for i = 3

--------------------------------------------

Iteration i = 2
Mean of 114 measurements = 222.399
Std Dev = 118.731
x(i+1) = 32.49 from measurement 1/7/2010 from location B-51
Rosner Statistic R = |32.49 - 222.399|/118.731 = 1.5995
Lambda(116, 3, 0.05) = 3.4216
1.5995 < 3.4216 -- No outliers detected for i = 2

--------------------------------------------

Iteration i = 1
Mean of 115 measurements = 224.257
Std Dev = 119.876
x(i+1) = 436.05 from measurement 4/3/2002 from location B-50
Rosner Statistic R = |436.05 - 224.257|/119.876 = 1.76677
Lambda(116, 2, 0.05) = 3.4216
1.76677 < 3.4216 -- No outliers detected for i = 1

--------------------------------------------

Iteration i = 0
Mean of 116 measurements = 226.229
Std Dev = 121.228
x(i+1) = 453 from measurement 7/2/2002 from location B-50
Rosner Statistic R = |453 - 226.229|/121.228 = 1.87061
Lambda(116, 1, 0.05) = 3.4248
1.87061 < 3.4248    No outliers detected for i = 0

**NO OUTLIERS DETECTED**

**Rosner's Test for Outliers**
**Parameter: Total Hardness**
**Background Locations**
**Original Data (Not Transformed)**

Data set mean = 226.229

10 most extreme of 116 measurements
by order of magnitude difference from the mean

| | | | | |
|---|---|---|---|---|
| 1 | 7/2/2002 | B-50 | 453 | 226.771 |
| 2 | 4/3/2002 | B-50 | 436.05 | 209.821 |
| 3 | 1/7/2010 | B-51 | 32.49 | -193.739 |
| 4 | 10/11/2006 | B-51 | 32.49 | -193.739 |
| 5 | 4/2/2003 | B-51 | 34.2 | -192.029 |
| 6 | 7/7/2010 | B-51 | 34.2 | -192.029 |
| 7 | 4/7/2010 | B-51 | 35.91 | -190.319 |
| 8 | 4/8/2009 | B-51 | 35.91 | -190.319 |
| 9 | 7/23/2003 | B-51 | 35.91 | -190.319 |
| 10 | 1/5/2006 | B-51 | 37.62 | -188.609 |

---

Iteration i = 9
Mean of 107 measurements = 234.696
Std Dev = 111.992
x(i+1) = 37.62 from measurement 1/5/2006 from location B-51
Rosner Statistic R = |37.62 - 234.696|/111.992 = 1.75973
Lambda(116, 10, 0.05) = 3.398
1.75973 < 3.398 -- No outliers detected for i = 9

---

Iteration i = 8
Mean of 108 measurements = 232.855
Std Dev = 113.097
x(i+1) = 35.91 from measurement 7/23/2003 from location B-51
Rosner Statistic R = |35.91 - 232.855|/113.097 = 1.74138
Lambda(116, 9, 0.05) = 3.40136
1.74138 < 3.40136 -- No outliers detected for i = 8

---

Iteration i = 7
Mean of 109 measurements = 231.048
Std Dev = 114.142
x(i+1) = 35.91 from measurement 4/8/2009 from location B-51
Rosner Statistic R = |35.91 - 231.048|/114.142 = 1.70962
Lambda(116, 8, 0.05) = 3.40472
1.70962 < 3.40472 -- No outliers detected for i = 7

---

Iteration i = 6
Mean of 110 measurements = 229.274
Std Dev = 115.13
x(i+1) = 35.91 from measurement 4/7/2010 from location B-51
Rosner Statistic R = |35.91 - 229.274|/115.13 = 1.67953
Lambda(116, 7, 0.05) = 3.40808
1.67953 < 3.40808 -- No outliers detected for i = 6

---

Iteration i = 5
Mean of 111 measurements = 227.517
Std Dev = 116.092
x(i+1) = 34.2 from measurement 7/7/2010 from location B-51
Rosner Statistic R = |34.2 - 227.517|/116.092 = 1.66521
Lambda(116, 6, 0.05) = 3.41144
1.66521 < 3.41144 -- No outliers detected for i = 5

---

Iteration i = 4
Mean of 112 measurements = 225.791
Std Dev = 117.002
x(i+1) = 34.2 from measurement 4/2/2003 from location B-51
Rosner Statistic R = |34.2 - 225.791|/117.002 = 1.6375
Lambda(116, 5, 0.05) = 3.4148
1.6375 < 3.4148 -- No outliers detected for i = 4

## Concentrations (mg/L) - Continued

**Parameter: Total Hardness**
**Original Data (Not Transformed)**
**Percent Background Non-Detects: 0%**
**Total Background Measurements: 116**
**There are 3 background locations**

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| | | | 10/22/2008 | 61.56 | 61.56 |
| | | | 1/13/2009 | 37.62 | 37.62 |
| | | | 4/8/2009 | 35.91 | 35.91 |
| | | | 7/15/2009 | 44.46 | 44.46 |
| | | | 1/7/2010 | 32.49 | 32.49 |
| | | | 4/7/2010 | 35.91 | 35.91 |
| | | | 7/7/2010 | 34.2 | 34.2 |
| | | | 8/16/2011 | 39.33 | 39.33 |
| | | | 10/26/2011 | 49.59 | 49.59 |
| B-50 | 42 | 0 (0%) | 11/15/2001 | 290.7 | 290.7 |
| | | | 1/16/2002 | 384.75 | 384.75 |
| | | | 4/3/2002 | 436.05 | 436.05 |
| | | | 7/2/2002 | 453 | 453 |
| | | | 10/2/2002 | 342 | 342 |
| | | | 1/8/2003 | 410.4 | 410.4 |
| | | | 4/2/2003 | 342 | 342 |
| | | | 7/23/2003 | 342 | 342 |
| | | | 10/2/2003 | 338.58 | 338.58 |
| | | | 1/7/2004 | 342 | 342 |
| | | | 4/7/2004 | 350.55 | 350.55 |
| | | | 7/13/2004 | 342 | 342 |
| | | | 10/6/2004 | 342 | 342 |
| | | | 1/6/2005 | 318.06 | 318.06 |
| | | | 4/6/2005 | 328.32 | 328.32 |
| | | | 7/27/2005 | 342 | 342 |
| | | | 10/13/2005 | 321.48 | 321.48 |
| | | | 1/5/2006 | 350.55 | 350.55 |
| | | | 4/6/2006 | 342 | 342 |
| | | | 7/25/2006 | 314.64 | 314.64 |
| | | | 10/11/2006 | 376.2 | 376.2 |
| | | | 1/4/2007 | 342 | 342 |
| | | | 4/4/2007 | 335.16 | 335.16 |
| | | | 7/12/2007 | 328.32 | 328.32 |
| | | | 10/10/2007 | 342 | 342 |
| | | | 1/16/2008 | 307.8 | 307.8 |
| | | | 4/3/2008 | 294.12 | 294.12 |
| | | | 7/23/2008 | 324.9 | 324.9 |
| | | | 10/22/2008 | 273.6 | 273.6 |
| | | | 1/13/2009 | 287.28 | 287.28 |
| | | | 4/8/2009 | 290.7 | 290.7 |
| | | | 7/15/2009 | 290.7 | 290.7 |
| | | | 10/8/2009 | 263.35 | 263.35 |
| | | | 1/7/2010 | 280.44 | 280.44 |
| | | | 4/7/2010 | 287.28 | 287.28 |
| | | | 7/7/2010 | 277.02 | 277.02 |
| | | | 12/8/2010 | 299.25 | 299.25 |
| | | | 2/3/2011 | 253.08 | 253.08 |
| | | | 4/13/2011 | 256.5 | 256.5 |
| | | | 8/16/2011 | 273.6 | 273.6 |
| | | | 10/26/2011 | 273.6 | 273.6 |
| | | | 1/18/2012 | 270.18 | 270.18 |

Concentrations (mg/L)
Parameter: Total Hardness
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-52 | 42 | 0 (0%) | 11/15/2001 | 164.16 | 164.16 |
| | | | 1/16/2002 | 213.75 | 213.75 |
| | | | 4/3/2002 | 239.4 | 239.4 |
| | | | 7/2/2002 | 364.23 | 364.23 |
| | | | 10/2/2002 | 374.49 | 374.49 |
| | | | 1/8/2003 | 342 | 342 |
| | | | 4/2/2003 | 345.42 | 345.42 |
| | | | 7/23/2003 | 369.36 | 369.36 |
| | | | 10/2/2003 | 191.52 | 191.52 |
| | | | 1/7/2004 | 268.47 | 268.47 |
| | | | 4/7/2004 | 220.59 | 220.59 |
| | | | 7/13/2004 | 232.56 | 232.56 |
| | | | 10/6/2004 | 287.28 | 287.28 |
| | | | 1/6/2005 | 232.56 | 232.56 |
| | | | 4/6/2005 | 290.7 | 290.7 |
| | | | 7/27/2005 | 365.94 | 365.94 |
| | | | 10/13/2005 | 307.8 | 307.8 |
| | | | 1/5/2006 | 256.5 | 256.5 |
| | | | 4/6/2006 | 280.44 | 280.44 |
| | | | 7/25/2006 | 300.96 | 300.96 |
| | | | 10/11/2006 | 249.66 | 249.66 |
| | | | 1/4/2007 | 200.07 | 200.07 |
| | | | 4/4/2007 | 297.54 | 297.54 |
| | | | 7/12/2007 | 229.14 | 229.14 |
| | | | 10/10/2007 | 247.95 | 247.95 |
| | | | 1/16/2008 | 209.7 | 209.7 |
| | | | 4/3/2008 | 266.76 | 266.76 |
| | | | 7/23/2008 | 218.88 | 218.88 |
| | | | 10/22/2008 | 212.04 | 212.04 |
| | | | 1/13/2009 | 212.04 | 212.04 |
| | | | 4/8/2009 | 314.64 | 314.64 |
| | | | 7/15/2009 | 196.64 | 196.64 |
| | | | 10/8/2009 | 273.6 | 273.6 |
| | | | 1/7/2010 | 290.7 | 290.7 |
| | | | 4/7/2010 | 280.44 | 280.44 |
| | | | 7/7/2010 | 283.86 | 283.86 |
| | | | 12/8/2010 | 290.7 | 290.7 |
| | | | 2/3/2011 | 256.5 | 256.5 |
| | | | 4/13/2011 | 273.6 | 273.6 |
| | | | 8/16/2011 | 259.92 | 259.92 |
| | | | 10/26/2011 | 218.88 | 218.88 |
| | | | 1/18/2012 | 239.4 | 239.4 |
| B-51 | 32 | 0 (0%) | 11/15/2001 | 128.25 | 128.25 |
| | | | 10/2/2002 | 54.72 | 54.72 |
| | | | 1/8/2003 | 47.88 | 47.88 |
| | | | 4/2/2003 | 34.2 | 34.2 |
| | | | 7/23/2003 | 35.91 | 35.91 |
| | | | 10/2/2003 | 41.04 | 41.04 |
| | | | 1/7/2004 | 46.17 | 46.17 |
| | | | 4/7/2004 | 41.04 | 41.04 |
| | | | 7/13/2004 | 42.75 | 42.75 |
| | | | 10/6/2004 | 42.75 | 42.75 |
| | | | 1/6/2005 | 39.33 | 39.33 |
| | | | 4/6/2005 | 42.75 | 42.75 |
| | | | 7/27/2005 | 46.17 | 46.17 |
| | | | 10/13/2005 | 49.59 | 49.59 |
| | | | 1/5/2006 | 37.62 | 37.62 |
| | | | 4/6/2006 | 68.4 | 68.4 |
| | | | 7/25/2006 | 47.88 | 47.88 |
| | | | 10/11/2006 | 32.49 | 32.49 |
| | | | 1/4/2007 | 46.17 | 46.17 |
| | | | 4/4/2007 | 44.46 | 44.46 |
| | | | 7/12/2007 | 39.33 | 39.33 |
| | | | 10/10/2007 | 71.82 | 71.82 |
| | | | 7/23/2008 | 59.85 | 59.85 |

**Non-Parametric Prediction Interval**
**Inter-Well Comparison**
**Parameter: Total Dissolved Solids (TDS)**
**Original Data (Not Transformed)**

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
**Maximum Background Value = 805**
Confidence Level = 99%
False Positive Rate = 1%

| Location | Date | Count | Mean | Significant |
|---|---|---|---|---|
| B-30A | 4/4/2012 | 1 | 185.5 | FALSE |
| B-32 | 4/4/2012 | 1 | 597 | FALSE |
| B-31 | 4/4/2012 | 1 | 43.5 | FALSE |
| DM-1 | 4/4/2012 | 1 | 393.5 | FALSE |
| DM-7 | 4/4/2012 | 1 | 91 | FALSE |
| DM-6 | 4/4/2012 | 1 | 96 | FALSE |
| DM-5 | 4/4/2012 | 1 | 437.5 | FALSE |

**Shapiro-Francia Test of Normality (Continued)**
**Parameter: Total Dissolved Solids (TDS)**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Natural Logarithm Transformation**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 6.04501 | 0.163659 | 54.4516 | -224.945 |
| 67 | 6.05678 | 0.184017 | 54.4854 | -223.831 |
| 68 | 6.05912 | 0.207012 | 54.5283 | -222.577 |
| 69 | 6.06611 | 0.227545 | 54.5801 | -221.196 |
| 70 | 6.06958 | 0.250759 | 54.643 | -219.674 |
| 71 | 6.08222 | 0.271509 | 54.7167 | -218.023 |
| 72 | 6.08222 | 0.294992 | 54.8037 | -216.229 |
| 73 | 6.08677 | 0.316004 | 54.9036 | -214.305 |
| 74 | 6.09018 | 0.33981 | 55.019 | -212.236 |
| 75 | 6.09582 | 0.363809 | 55.1514 | -210.018 |
| 76 | 6.10032 | 0.385321 | 55.2999 | -207.667 |
| 77 | 6.10032 | 0.409735 | 55.4677 | -205.168 |
| 78 | 6.10144 | 0.431644 | 55.6541 | -202.534 |
| 79 | 6.11147 | 0.456542 | 55.8625 | -199.744 |
| 80 | 6.11368 | 0.478914 | 56.0918 | -196.816 |
| 81 | 6.12249 | 0.504372 | 56.3462 | -193.728 |
| 82 | 6.12468 | 0.52728 | 56.6243 | -190.499 |
| 83 | 6.14204 | 0.553384 | 56.9305 | -187.1 |
| 84 | 6.14526 | 0.576911 | 57.2633 | -183.555 |
| 85 | 6.1506 | 0.603765 | 57.6278 | -179.841 |
| 86 | 6.16856 | 0.631062 | 58.0261 | -175.948 |
| 87 | 6.17379 | 0.655726 | 58.4561 | -171.9 |
| 88 | 6.18312 | 0.68396 | 58.9239 | -167.671 |
| 89 | 6.18724 | 0.709522 | 59.4273 | -163.281 |
| 90 | 6.22059 | 0.738846 | 59.9732 | -158.685 |
| 91 | 6.22456 | 0.765456 | 60.5591 | -153.92 |
| 92 | 6.24222 | 0.796056 | 61.1928 | -148.951 |
| 93 | 6.2432 | 0.823893 | 61.8716 | -143.807 |
| 94 | 6.2519 | 0.855996 | 62.6043 | -138.456 |
| 95 | 6.26435 | 0.885291 | 63.3881 | -132.91 |
| 96 | 6.27004 | 0.919183 | 64.233 | -127.147 |
| 97 | 6.27382 | 0.954165 | 65.1434 | -121.16 |
| 98 | 6.28133 | 0.986272 | 66.1161 | -114.965 |
| 99 | 6.29249 | 1.02365 | 67.164 | -108.524 |
| 100 | 6.31173 | 1.05812 | 68.2836 | -101.845 |
| 101 | 6.31626 | 1.09847 | 69.4903 | -94.9072 |
| 102 | 6.32972 | 1.1359 | 70.7805 | -87.7173 |
| 103 | 6.32972 | 1.18 | 72.1729 | -80.2483 |
| 104 | 6.35089 | 1.22123 | 73.6643 | -72.4924 |
| 105 | 6.3699 | 1.27024 | 75.2778 | -64.4011 |
| 106 | 6.3894 | 1.31652 | 77.011 | -55.9893 |
| 107 | 6.39359 | 1.3722 | 78.894 | -47.216 |
| 108 | 6.41673 | 1.4325 | 80.9461 | -38.024 |
| 109 | 6.44889 | 1.49085 | 83.1687 | -28.4097 |
| 110 | 6.4708 | 1.56322 | 85.6124 | -18.2944 |
| 111 | 6.47928 | 1.63524 | 88.2864 | -7.69923 |
| 112 | 6.53669 | 1.72793 | 91.2721 | 3.59572 |
| 113 | 6.58064 | 1.82501 | 94.6027 | 15.6054 |
| 114 | 6.62007 | 1.95996 | 98.4442 | 28.5805 |
| 115 | 6.64379 | 2.12007 | 102.939 | 42.6658 |
| 116 | 6.69084 | 2.40892 | 108.742 | 58.7835 |

Data Set Standard Deviation = 0.550578
Numerator = 3455.5
Denominator = 3790.81
W Statistic = 0.911547 = 3455.5 / 3790.81

5% Critical value of 0.976 exceeds 0.911547
Evidence of non-normality at 95% level of significance

**Shapiro-Francia Test of Normality**
**Parameter: Total Dissolved Solids (TDS)**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Natural Logarithm Transformation**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 3.95124 | -2.40892 | 5.80292 | -9.51825 |
| 2 | 4.62006 | -2.12007 | 10.2976 | -19.3131 |
| 3 | 4.62986 | -1.95996 | 14.1391 | -28.3874 |
| 4 | 4.67563 | -1.82501 | 17.4697 | -36.9205 |
| 5 | 4.7185 | -1.72793 | 20.4554 | -45.0737 |
| 6 | 4.82028 | -1.63524 | 23.1294 | -52.956 |
| 7 | 4.84024 | -1.56322 | 25.5731 | -60.5224 |
| 8 | 4.85593 | -1.49085 | 27.7957 | 67.7619 |
| 9 | 4.8752 | -1.4325 | 29.8478 | -74.7456 |
| 10 | 4.89035 | -1.3722 | 31.7308 | -81.4562 |
| 11 | 4.90527 | -1.31652 | 33.464 | -87.9141 |
| 12 | 4.94521 | -1.27024 | 35.0775 | -94.1956 |
| 13 | 4.96494 | -1.22123 | 36.5689 | -100.259 |
| 14 | 4.99043 | -1.18 | 37.9613 | -106.148 |
| 15 | 4.99383 | -1.1359 | 39.2515 | -111.82 |
| 16 | 5.04343 | -1.09847 | 40.4582 | -117.36 |
| 17 | 5.046 | -1.05812 | 41.5778 | -122.699 |
| 18 | 5.05943 | -1.02365 | 42.6257 | -127.879 |
| 19 | 5.12694 | -0.986272 | 43.5984 | -132.935 |
| 20 | 5.16479 | -0.954165 | 44.5088 | -137.863 |
| 21 | 5.16764 | -0.919183 | 45.3537 | -142.613 |
| 22 | 5.20401 | -0.885291 | 46.1375 | -147.22 |
| 23 | 5.20401 | -0.855996 | 46.8702 | -151.675 |
| 24 | 5.21494 | -0.823893 | 47.549 | -155.971 |
| 25 | 5.22036 | 0.796056 | 48.1827 | -160.127 |
| 26 | 5.23111 | -0.765456 | 48.7686 | -164.131 |
| 27 | 5.24175 | -0.738846 | 49.3145 | -168.004 |
| 28 | 5.26786 | -0.709522 | 49.8179 | -171.742 |
| 29 | 5.29832 | 0.68396 | 50.2857 | -175.366 |
| 30 | 5.45959 | -0.655726 | 50.7157 | -178.946 |
| 31 | 5.53733 | -0.631062 | 51.114 | -182.44 |
| 32 | 5.60396 | -0.603765 | 51.4785 | -185.824 |
| 33 | 5.64368 | -0.576911 | 51.8113 | -189.079 |
| 34 | 5.68358 | -0.553384 | 52.1175 | -192.225 |
| 35 | 5.69709 | -0.52728 | 52.3956 | -195.229 |
| 36 | 5.70378 | -0.504372 | 52.65 | -198.105 |
| 37 | 5.78074 | -0.478914 | 52.8793 | -200.874 |
| 38 | 5.78843 | -0.456542 | 53.0877 | -203.517 |
| 39 | 5.79301 | -0.431644 | 53.2741 | -206.017 |
| 40 | 5.81264 | -0.409735 | 53.4419 | -208.399 |
| 41 | 5.81413 | -0.385321 | 53.5904 | -210.639 |
| 42 | 5.8186 | -0.363809 | 53.7228 | -212.756 |
| 43 | 5.82747 | -0.33981 | 53.8382 | -214.736 |
| 44 | 5.83188 | -0.316004 | 53.9381 | -216.579 |
| 45 | 5.84932 | -0.294992 | 54.0251 | -218.305 |
| 46 | 5.86079 | -0.271509 | 54.0988 | -219.896 |
| 47 | 5.86363 | -0.250759 | 54.1617 | -221.366 |
| 48 | 5.88332 | -0.227545 | 54.2135 | -222.705 |
| 49 | 5.89302 | -0.207012 | 54.2564 | -223.925 |
| 50 | 5.8999 | -0.184017 | 54.2902 | -225.01 |
| 51 | 5.8999 | -0.163659 | 54.317 | -225.976 |
| 52 | 5.92559 | -0.140835 | 54.3368 | -226.811 |
| 53 | 5.94673 | -0.12061 | 54.3514 | -227.528 |
| 54 | 5.95324 | -0.0979139 | 54.361 | -228.111 |
| 55 | 5.96615 | -0.0752698 | 54.3666 | -228.56 |
| 56 | 5.98015 | -0.0551734 | 54.3697 | -228.89 |
| 57 | 5.98268 | -0.0325917 | 54.3707 | -229.085 |
| 58 | 5.98519 | -0.0125328 | 54.3709 | -229.16 |
| 59 | 5.99396 | 0.0125328 | 54.3711 | -229.085 |
| 60 | 5.99894 | 0.0325917 | 54.3721 | -228.889 |
| 61 | 6.01859 | 0.0551734 | 54.3752 | -228.557 |
| 62 | 6.02102 | 0.0752698 | 54.3808 | -228.104 |
| 63 | 6.02102 | 0.0979139 | 54.3904 | -227.514 |
| 64 | 6.04025 | 0.12061 | 54.405 | -226.786 |
| 65 | 6.04263 | 0.140835 | 54.4248 | -225.935 |

## Shapiro-Francia Test of Normality (Continued)

**Parameter: Total Dissolved Solids (TDS)**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 422 | 0.163659 | 54.4516 | -7582.49 |
| 67 | 427 | 0.184017 | 54.4854 | -7503.91 |
| 68 | 428 | 0.207012 | 54.5283 | -7415.31 |
| 69 | 431 | 0.227545 | 54.5801 | -7317.24 |
| 70 | 432.5 | 0.250759 | 54.643 | -7208.79 |
| 71 | 438 | 0.271509 | 54.7167 | -7089.87 |
| 72 | 438 | 0.294992 | 54.8037 | -6960.66 |
| 73 | 440 | 0.316004 | 54.9036 | -6821.62 |
| 74 | 441.5 | 0.33981 | 55.019 | -6671.59 |
| 75 | 444 | 0.363809 | 55.1514 | -6510.06 |
| 76 | 446 | 0.385321 | 55.2999 | -6338.21 |
| 77 | 446 | 0.409735 | 55.4677 | -6155.47 |
| 78 | 446.5 | 0.431644 | 55.6541 | -5962.74 |
| 79 | 451 | 0.456542 | 55.8625 | -5756.84 |
| 80 | 452 | 0.478914 | 56.0918 | -5540.37 |
| 81 | 456 | 0.504372 | 56.3462 | -5310.37 |
| 82 | 457 | 0.52728 | 56.6243 | -5069.41 |
| 83 | 465 | 0.553384 | 56.9305 | -4812.08 |
| 84 | 466.5 | 0.576911 | 57.2633 | -4542.95 |
| 85 | 469 | 0.603765 | 57.6278 | -4259.79 |
| 86 | 477.5 | 0.631062 | 58.0261 | -3958.46 |
| 87 | 480 | 0.655726 | 58.4561 | -3643.71 |
| 88 | 484.5 | 0.68396 | 58.9239 | -3312.33 |
| 89 | 486.5 | 0.709522 | 59.4273 | -2967.15 |
| 90 | 503 | 0.738846 | 59.9732 | -2595.51 |
| 91 | 505 | 0.765456 | 60.5591 | -2208.95 |
| 92 | 514 | 0.796056 | 61.1928 | -1799.78 |
| 93 | 514.5 | 0.823893 | 61.8716 | -1375.89 |
| 94 | 519 | 0.855996 | 62.6043 | -931.624 |
| 95 | 525.5 | 0.885291 | 63.3881 | -466.404 |
| 96 | 528.5 | 0.919183 | 64.233 | 19.3848 |
| 97 | 530.5 | 0.954165 | 65.1434 | 525.569 |
| 98 | 534.5 | 0.986272 | 66.1161 | 1052.73 |
| 99 | 540.5 | 1.02365 | 67.164 | 1606.02 |
| 100 | 551 | 1.05812 | 68.2836 | 2189.04 |
| 101 | 553.5 | 1.09847 | 69.4903 | 2797.04 |
| 102 | 561 | 1.1359 | 70.7805 | 3434.28 |
| 103 | 561 | 1.18 | 72.1729 | 4096.26 |
| 104 | 573 | 1.22123 | 73.6643 | 4796.03 |
| 105 | 584 | 1.27024 | 75.2778 | 5537.84 |
| 106 | 595.5 | 1.31652 | 77.011 | 6321.83 |
| 107 | 598 | 1.3722 | 78.894 | 7142.41 |
| 108 | 612 | 1.4325 | 80.9461 | 8019.1 |
| 109 | 632 | 1.49085 | 83.1687 | 8961.32 |
| 110 | 646 | 1.56322 | 85.6124 | 9971.16 |
| 111 | 651.5 | 1.63524 | 88.2864 | 11036.5 |
| 112 | 690 | 1.72793 | 91.2721 | 12228.8 |
| 113 | 721 | 1.82501 | 94.6027 | 13544.6 |
| 114 | 750 | 1.95996 | 98.4442 | 15014.6 |
| 115 | 768 | 2.12007 | 102.939 | 16642.8 |
| 116 | 805 | 2.40892 | 108.742 | 18582 |

Data Set Standard Deviation = 168.374
Numerator = 3.4529e+008
Denominator = 3.54523e+008
W Statistic = 0.973956 = 3.4529e+008 / 3.54523e+008

5% Critical value of 0.976 exceeds 0.973956
Evidence of non-normality at 95% level of significance

**Shapiro-Francia Test of Normality**
**Parameter: Total Dissolved Solids (TDS)**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 52 | -2.40892 | 5.80292 | -125.264 |
| 2 | 101.5 | -2.12007 | 10.2976 | -340.451 |
| 3 | 102.5 | -1.95996 | 14.1391 | -541.347 |
| 4 | 107.3 | -1.82501 | 17.4697 | -737.17 |
| 5 | 112 | -1.72793 | 20.4554 | -930.698 |
| 6 | 124 | -1.63524 | 23.1294 | -1133.47 |
| 7 | 126.5 | -1.56322 | 25.5731 | -1331.22 |
| 8 | 128.5 | -1.49085 | 27.7957 | -1522.79 |
| 9 | 131 | -1.4325 | 29.8478 | -1710.45 |
| 10 | 133 | -1.3722 | 31.7308 | -1892.95 |
| 11 | 135 | -1.31652 | 33.464 | -2070.68 |
| 12 | 140.5 | -1.27024 | 35.0775 | -2249.15 |
| 13 | 143.3 | -1.22123 | 36.5689 | -2424.15 |
| 14 | 147 | -1.18 | 37.9613 | -2597.61 |
| 15 | 147.5 | -1.1359 | 39.2515 | -2765.16 |
| 16 | 155 | -1.09847 | 40.4582 | -2935.42 |
| 17 | 155.4 | -1.05812 | 41.5778 | -3099.85 |
| 18 | 157.5 | -1.02365 | 42.6257 | -3261.08 |
| 19 | 168.5 | -0.986272 | 43.5984 | -3427.26 |
| 20 | 175 | -0.954165 | 44.5088 | -3594.24 |
| 21 | 175.5 | -0.919183 | 45.3537 | -3755.56 |
| 22 | 182 | -0.885291 | 46.1375 | -3916.68 |
| 23 | 182 | -0.855996 | 46.8702 | -4072.47 |
| 24 | 184 | -0.823893 | 47.549 | -4224.07 |
| 25 | 185 | -0.796056 | 48.1827 | -4371.34 |
| 26 | 187 | -0.765456 | 48.7686 | -4514.48 |
| 27 | 189 | -0.738846 | 49.3145 | -4654.12 |
| 28 | 194 | -0.709522 | 49.8179 | -4791.77 |
| 29 | 200 | -0.68396 | 50.2857 | -4928.56 |
| 30 | 235 | -0.655726 | 50.7157 | -5082.66 |
| 31 | 254 | -0.631062 | 51.114 | -5242.95 |
| 32 | 271.5 | -0.603765 | 51.4785 | -5406.87 |
| 33 | 282.5 | -0.576911 | 51.8113 | -5569.85 |
| 34 | 294 | -0.553384 | 52.1175 | -5732.54 |
| 35 | 298 | -0.52728 | 52.3956 | -5889.67 |
| 36 | 300 | -0.504372 | 52.65 | -6040.98 |
| 37 | 324 | -0.478914 | 52.8793 | -6196.15 |
| 38 | 326.5 | -0.456542 | 53.0877 | -6345.21 |
| 39 | 328 | -0.431644 | 53.2741 | -6486.79 |
| 40 | 334.5 | -0.409735 | 53.4419 | -6623.85 |
| 41 | 335 | -0.385321 | 53.5904 | -6752.93 |
| 42 | 336.5 | -0.363809 | 53.7228 | -6875.35 |
| 43 | 339.5 | -0.33981 | 53.8382 | -6990.72 |
| 44 | 341 | -0.316004 | 53.9381 | -7098.47 |
| 45 | 347 | -0.294992 | 54.0251 | -7200.84 |
| 46 | 351 | -0.271509 | 54.0988 | -7296.14 |
| 47 | 352 | -0.250759 | 54.1617 | -7384.4 |
| 48 | 359 | -0.227545 | 54.2135 | -7466.09 |
| 49 | 362.5 | -0.207012 | 54.2564 | -7541.13 |
| 50 | 365 | -0.184017 | 54.2902 | -7608.3 |
| 51 | 365 | -0.163659 | 54.317 | -7668.04 |
| 52 | 374.5 | -0.140835 | 54.3368 | -7720.78 |
| 53 | 382.5 | -0.12061 | 54.3514 | -7766.91 |
| 54 | 385 | -0.0979139 | 54.361 | -7804.61 |
| 55 | 390 | -0.0752698 | 54.3666 | -7833.96 |
| 56 | 395.5 | -0.0551734 | 54.3697 | -7855.78 |
| 57 | 396.5 | -0.0325917 | 54.3707 | -7868.71 |
| 58 | 397.5 | -0.0125328 | 54.3709 | -7873.69 |
| 59 | 401 | 0.0125328 | 54.3711 | -7868.66 |
| 60 | 403 | 0.0325917 | 54.3721 | -7855.53 |
| 61 | 411 | 0.0551734 | 54.3752 | -7832.85 |
| 62 | 412 | 0.0752698 | 54.3808 | -7801.84 |
| 63 | 412 | 0.0979139 | 54.3904 | -7761.5 |
| 64 | 420 | 0.12061 | 54.405 | -7710.84 |
| 65 | 421 | 0.140835 | 54.4248 | -7651.55 |

**Rosner's Test for Outliers (Continued)**
**Parameter: Total Dissolved Solids (TDS)**
**Background Locations**
**Original Data (Not Transformed)**

---

Iteration i = 3
Mean of 113 measurements = 368.093
Std Dev = 157.445
x(i+1) = 721 from measurement 4/6/2006 from location B-52
Rosner Statistic R = |721 - 368.093|/157.445 = 2.24146
Lambda(116, 4, 0.05) = 3.4148
2.24146 < 3.4148 -- No outliers detected for i = 3

---

Iteration i = 2
Mean of 114 measurements = 371.443
Std Dev = 160.776
x(i+1) = 750 from measurement 4/6/2005 from location B-52
Rosner Statistic R = |750 - 371.443|/160.776 = 2.35456
Lambda(116, 3, 0.05) = 3.4216
2.35456 < 3.4216 -- No outliers detected for i = 2

---

Iteration i = 1
Mean of 115 measurements = 374.891
Std Dev = 164.286
x(i+1) = 768 from measurement 7/25/2006 from location B-52
Rosner Statistic R = |768 - 374.891|/164.286 = 2.39284
Lambda(116, 2, 0.05) = 3.4216
2.39284 < 3.4216 -- No outliers detected for i = 1

---

Iteration i = 0
Mean of 116 measurements = 378.599
Std Dev = 168.374
x(i+1) = 805 from measurement 1/6/2005 from location B-52
Rosner Statistic R = |805 - 378.599|/168.374 = 2.53246
Lambda(116, 1, 0.05) = 3.4248
2.53246 < 3.4248 -- No outliers detected for i = 0

**NO OUTLIERS DETECTED**

**Rosner's Test for Outliers**
**Parameter: Total Dissolved Solids (TDS)**
**Background Locations**
**Original Data (Not Transformed)**

Data set mean = 378.599

10 most extreme of 116 measurements
by order of magnitude difference from the mean

| | | | | |
|---|---|---|---|---|
| 1 | 1/6/2005 | B-52 | 805 | 426.401 |
| 2 | 7/25/2006 | B-52 | 768 | 389.401 |
| 3 | 4/6/2005 | B-52 | 750 | 371.401 |
| 4 | 4/6/2006 | B-52 | 721 | 342.401 |
| 5 | 4/4/2007 | B-51 | 52 | -326.599 |
| 6 | 7/13/2004 | B-52 | 690 | 311.401 |
| 7 | 7/25/2006 | B-51 | 101.5 | -277.099 |
| 8 | 1/13/2009 | B-51 | 102.5 | -276.099 |
| 9 | 7/27/2005 | B-52 | 651.5 | 272.901 |
| 10 | 4/8/2009 | B-51 | 107.3 | -271.299 |

-------------------------------------------

Iteration i = 9
Mean of 107 measurements = 367.065
Std Dev = 144.922
x(i+1) = 107.3 from measurement 4/8/2009 from location B-51
Rosner Statistic R = |107.3 - 367.065|/144.922 = 1.79245
Lambda(116, 10, 0.05) = 3.398
1.79245 < 3.398 -- No outliers detected for i = 9

-------------------------------------------

Iteration i = 8
Mean of 108 measurements = 369.699
Std Dev = 146.817
x(i+1) = 651.5 from measurement 7/27/2005 from location B-52
Rosner Statistic R = |651.5 - 369.699|/146.817 = 1.91941
Lambda(116, 9, 0.05) = 3.40136
1.91941 < 3.40136 -- No outliers detected for i = 8

-------------------------------------------

Iteration i = 7
Mean of 109 measurements = 367.248
Std Dev = 148.359
x(i+1) = 102.5 from measurement 1/13/2009 from location B-51
Rosner Statistic R = |102.5 - 367.248|/148.359 = 1.7845
Lambda(116, 8, 0.05) = 3.40472
1.7845 < 3.40472 -- No outliers detected for i = 7

-------------------------------------------

Iteration i = 6
Mean of 110 measurements = 364.832
Std Dev = 149.835
x(i+1) = 101.5 from measurement 7/25/2006 from location B-51
Rosner Statistic R = |101.5 - 364.832|/149.835 = 1.75748
Lambda(116, 7, 0.05) = 3.40808
1.75748 < 3.40808 -- No outliers detected for i = 6

-------------------------------------------

Iteration i = 5
Mean of 111 measurements = 367.761
Std Dev = 152.312
x(i+1) = 690 from measurement 7/13/2004 from location B-52
Rosner Statistic R = |690 - 367.761|/152.312 = 2.11564
Lambda(116, 6, 0.05) = 3.41144
2.11564 < 3.41144 -- No outliers detected for i = 5

-------------------------------------------

Iteration i = 4
Mean of 112 measurements = 364.942
Std Dev = 154.532
x(i+1) = 52 from measurement 4/4/2007 from location B-51
Rosner Statistic R = |52 - 364.942|/154.532 = 2.02509
Lambda(116, 5, 0.05) = 3.4148
2.02509 < 3.4148 -- No outliers detected for i = 4

## Concentrations (mg/L) - Continued

**Parameter: Total Dissolved Solids (TDS)**
**Original Data (Not Transformed)**
**Percent Background Non-Detects: 0%**
**Total Background Measurements: 116**
**There are 3 background locations**

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| | | | 10/22/2008 | 294 | 294 |
| | | | 1/13/2009 | 102.5 | 102.5 |
| | | | 4/8/2009 | 107.3 | 107.3 |
| | | | 7/15/2009 | 282.5 | 282.5 |
| | | | 1/7/2010 | 143.3 | 143.3 |
| | | | 4/7/2010 | 155.4 | 155.4 |
| | | | 7/7/2010 | 184 | 184 |
| | | | 8/16/2011 | 128.5 | 128.5 |
| | | | 10/26/2011 | 112 | 112 |
| B-50 | 42 | 0 (0%) | 11/15/2001 | 452 | 452 |
| | | | 1/16/2002 | 457 | 457 |
| | | | 4/3/2002 | 401 | 401 |
| | | | 7/2/2002 | 428 | 428 |
| | | | 10/2/2002 | 446 | 446 |
| | | | 1/8/2003 | 446.5 | 446.5 |
| | | | 4/2/2003 | 432.5 | 432.5 |
| | | | 7/23/2003 | 451 | 451 |
| | | | 10/2/2003 | 505 | 505 |
| | | | 1/7/2004 | 254 | 254 |
| | | | 4/7/2004 | 484.5 | 484.5 |
| | | | 7/13/2004 | 427 | 427 |
| | | | 10/6/2004 | 446 | 446 |
| | | | 1/6/2005 | 438 | 438 |
| | | | 4/6/2005 | 135 | 135 |
| | | | 7/27/2005 | 385 | 385 |
| | | | 10/13/2005 | 420 | 420 |
| | | | 1/5/2006 | 412 | 412 |
| | | | 4/6/2006 | 422 | 422 |
| | | | 7/25/2006 | 395.5 | 395.5 |
| | | | 10/11/2006 | 403 | 403 |
| | | | 1/4/2007 | 421 | 421 |
| | | | 4/4/2007 | 397.5 | 397.5 |
| | | | 7/12/2007 | 412 | 412 |
| | | | 10/10/2007 | 362.5 | 362.5 |
| | | | 1/16/2008 | 374.5 | 374.5 |
| | | | 4/3/2008 | 365 | 365 |
| | | | 7/23/2008 | 411 | 411 |
| | | | 10/22/2008 | 365 | 365 |
| | | | 1/13/2009 | 334.5 | 334.5 |
| | | | 4/8/2009 | 352 | 352 |
| | | | 7/15/2009 | 326.5 | 326.5 |
| | | | 10/8/2009 | 339.5 | 339.5 |
| | | | 1/7/2010 | 324 | 324 |
| | | | 4/7/2010 | 351 | 351 |
| | | | 7/7/2010 | 336.5 | 336.5 |
| | | | 12/8/2010 | 465 | 465 |
| | | | 2/3/2011 | 347 | 347 |
| | | | 4/13/2011 | 382.5 | 382.5 |
| | | | 8/16/2011 | 328 | 328 |
| | | | 10/26/2011 | 298 | 298 |
| | | | 1/18/2012 | 300 | 300 |

Concentrations (mg/L)

**Parameter: Total Dissolved Solids (TDS)**
**Original Data (Not Transformed)**
**Percent Background Non-Detects: 0%**
**Total Background Measurements: 116**
**There are 3 background locations**

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-52 | 42 | 0 (0%) | 11/15/2001 | 271.5 | 271.5 |
| | | | 1/16/2002 | 480 | 480 |
| | | | 4/3/2002 | 486.5 | 486.5 |
| | | | 7/2/2002 | 534.5 | 534.5 |
| | | | 10/2/2002 | 598 | 598 |
| | | | 1/8/2003 | 440 | 440 |
| | | | 4/2/2003 | 514 | 514 |
| | | | 7/23/2003 | 519 | 519 |
| | | | 10/2/2003 | 456 | 456 |
| | | | 1/7/2004 | 584 | 584 |
| | | | 4/7/2004 | 573 | 573 |
| | | | 7/13/2004 | 690 | 690 |
| | | | 10/6/2004 | 612 | 612 |
| | | | 1/6/2005 | 805 | 805 |
| | | | 4/6/2005 | 750 | 750 |
| | | | 7/27/2005 | 651.5 | 651.5 |
| | | | 10/13/2005 | 503 | 503 |
| | | | 1/5/2006 | 632 | 632 |
| | | | 4/6/2006 | 721 | 721 |
| | | | 7/25/2006 | 768 | 768 |
| | | | 10/11/2006 | 438 | 438 |
| | | | 1/4/2007 | 561 | 561 |
| | | | 4/4/2007 | 514.5 | 514.5 |
| | | | 7/12/2007 | 477.5 | 477.5 |
| | | | 10/10/2007 | 390 | 390 |
| | | | 1/16/2008 | 396.5 | 396.5 |
| | | | 4/3/2008 | 551 | 551 |
| | | | 7/23/2008 | 553.5 | 553.5 |
| | | | 10/22/2008 | 530.5 | 530.5 |
| | | | 1/13/2009 | 335 | 335 |
| | | | 4/8/2009 | 469 | 469 |
| | | | 7/15/2009 | 444 | 444 |
| | | | 10/8/2009 | 540.5 | 540.5 |
| | | | 1/7/2010 | 431 | 431 |
| | | | 4/7/2010 | 561 | 561 |
| | | | 7/7/2010 | 595.5 | 595.5 |
| | | | 12/8/2010 | 341 | 341 |
| | | | 2/3/2011 | 528.5 | 528.5 |
| | | | 4/13/2011 | 646 | 646 |
| | | | 8/16/2011 | 525.5 | 525.5 |
| | | | 10/26/2011 | 359 | 359 |
| | | | 1/18/2012 | 466.5 | 466.5 |
| B-51 | 32 | 0 (0%) | 11/15/2001 | 126.5 | 126.5 |
| | | | 10/2/2002 | 157.5 | 157.5 |
| | | | 1/8/2003 | 168.5 | 168.5 |
| | | | 4/2/2003 | 124 | 124 |
| | | | 7/23/2003 | 140.5 | 140.5 |
| | | | 10/2/2003 | 185 | 185 |
| | | | 1/7/2004 | 131 | 131 |
| | | | 4/7/2004 | 175.5 | 175.5 |
| | | | 7/13/2004 | 182 | 182 |
| | | | 10/6/2004 | 187 | 187 |
| | | | 1/6/2005 | 200 | 200 |
| | | | 4/6/2005 | 441.5 | 441.5 |
| | | | 7/27/2005 | 189 | 189 |
| | | | 10/13/2005 | 182 | 182 |
| | | | 1/5/2006 | 147.5 | 147.5 |
| | | | 4/6/2006 | 175 | 175 |
| | | | 7/25/2006 | 101.5 | 101.5 |
| | | | 10/11/2006 | 147 | 147 |
| | | | 1/4/2007 | 133 | 133 |
| | | | 4/4/2007 | 52 | 52 |
| | | | 7/12/2007 | 194 | 194 |
| | | | 10/10/2007 | 155 | 155 |
| | | | 7/23/2008 | 235 | 235 |

**Non-Parametric Prediction Interval**
**Inter-Well Comparison**
**Parameter: Sulfate**
**Original Data (Not Transformed)**

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
**Maximum Background Value = 439.51**
Confidence Level = 99%
False Positive Rate = 1%

| Location | Date | Count | Mean | Significant |
|---|---|---|---|---|
| B-30A | 4/4/2012 | 1 | 0.3 | FALSE |
| B-32 | 4/4/2012 | 1 | 238.89 | FALSE |
| B-31 | 4/4/2012 | 1 | 5.55 | FALSE |
| DM-1 | 4/4/2012 | 1 | 234.85 | FALSE |
| DM-7 | 4/4/2012 | 1 | 11.75 | FALSE |
| DM-6 | 4/4/2012 | 1 | 7.08 | FALSE |
| DM-5 | 4/4/2012 | 1 | 146.25 | FALSE |

## Shapiro-Francia Test of Normality (Continued)

**Parameter: Sulfate**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Natural Logarithm Transformation**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 3.94951 | 0.163659 | 54.4516 | -149.197 |
| 67 | 3.99489 | 0.184017 | 54.4854 | -148.462 |
| 68 | 4.01458 | 0.207012 | 54.5283 | -147.631 |
| 69 | 4.04323 | 0.227545 | 54.5801 | -146.711 |
| 70 | 4.06354 | 0.250759 | 54.643 | -145.692 |
| 71 | 4.07889 | 0.271509 | 54.7167 | -144.585 |
| 72 | 4.10446 | 0.294992 | 54.8037 | -143.374 |
| 73 | 4.14393 | 0.316004 | 54.9036 | -142.065 |
| 74 | 4.32281 | 0.33981 | 55.019 | -140.596 |
| 75 | 5.23692 | 0.363809 | 55.1514 | -138.69 |
| 76 | 5.24976 | 0.385321 | 55.2999 | -136.668 |
| 77 | 5.27413 | 0.409735 | 55.4677 | -134.507 |
| 78 | 5.30866 | 0.431644 | 55.6541 | -132.215 |
| 79 | 5.3272 | 0.456542 | 55.8625 | -129.783 |
| 80 | 5.36584 | 0.478914 | 56.0918 | -127.213 |
| 81 | 5.41801 | 0.504372 | 56.3462 | -124.481 |
| 82 | 5.42477 | 0.52728 | 56.6243 | -121.62 |
| 83 | 5.43525 | 0.553384 | 56.9305 | -118.612 |
| 84 | 5.44397 | 0.576911 | 57.2633 | -115.472 |
| 85 | 5.44889 | 0.603765 | 57.6278 | -112.182 |
| 86 | 5.49417 | 0.631062 | 58.0261 | -108.715 |
| 87 | 5.50065 | 0.655726 | 58.4561 | -105.108 |
| 88 | 5.51383 | 0.68396 | 58.9239 | -101.337 |
| 89 | 5.52454 | 0.709522 | 59.4273 | -97.4167 |
| 90 | 5.52824 | 0.738846 | 59.9732 | -93.3322 |
| 91 | 5.52875 | 0.765456 | 60.5591 | -89.1002 |
| 92 | 5.55853 | 0.796056 | 61.1928 | -84.6753 |
| 93 | 5.56685 | 0.823893 | 61.8716 | -80.0888 |
| 94 | 5.57811 | 0.855996 | 62.6043 | -75.314 |
| 95 | 5.60488 | 0.885291 | 63.3881 | -70.352 |
| 96 | 5.61502 | 0.919183 | 64.233 | -65.1908 |
| 97 | 5.64255 | 0.954165 | 65.1434 | -59.8069 |
| 98 | 5.66494 | 0.986272 | 66.1161 | -54.2197 |
| 99 | 5.68017 | 1.02365 | 67.164 | -48.4052 |
| 100 | 5.68096 | 1.05812 | 68.2836 | -42.394 |
| 101 | 5.71518 | 1.09847 | 69.4903 | -36.1161 |
| 102 | 5.72919 | 1.1359 | 70.7805 | -29.6083 |
| 103 | 5.75149 | 1.18 | 72.1729 | -22.8216 |
| 104 | 5.75637 | 1.22123 | 73.6643 | -15.7917 |
| 105 | 5.76353 | 1.27024 | 75.2778 | -8.47067 |
| 106 | 5.76751 | 1.31652 | 77.011 | -0.877622 |
| 107 | 5.83053 | 1.3722 | 78.894 | 7.12306 |
| 108 | 5.83968 | 1.4325 | 80.9461 | 15.4884 |
| 109 | 5.85252 | 1.49085 | 83.1687 | 24.2137 |
| 110 | 5.87796 | 1.56322 | 85.6124 | 33.4022 |
| 111 | 5.89123 | 1.63524 | 88.2864 | 43.0358 |
| 112 | 5.9125 | 1.72793 | 91.2721 | 53.2522 |
| 113 | 5.94657 | 1.82501 | 94.6027 | 64.1047 |
| 114 | 5.96781 | 1.95996 | 98.4442 | 75.8014 |
| 115 | 6.00566 | 2.12007 | 102.939 | 88.5338 |
| 116 | 6.08566 | 2.40892 | 108.742 | 103.194 |

Data Set Standard Deviation = 1.01884
Numerator = 10648.9
Denominator = 12981
W Statistic = 0.82035 = 10648.9 / 12981

5% Critical value of 0.976 exceeds 0.82035
Evidence of non-normality at 95% level of significance

## Shapiro-Francia Test of Normality

**Parameter: Sulfate**

**Background Locations**

**Normality Test of Parameter Concentrations**

**Natural Logarithm Transformation**

**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 3.168 | -2.40892 | 5.80292 | -7.63148 |
| 2 | 3.23475 | -2.12007 | 10.2976 | -14.4894 |
| 3 | 3.24415 | -1.95996 | 14.1391 | -20.8478 |
| 4 | 3.25154 | -1.82501 | 17.4697 | -26.7819 |
| 5 | 3.26576 | -1.72793 | 20.4554 | -32.4249 |
| 6 | 3.27526 | -1.63524 | 23.1294 | -37.7807 |
| 7 | 3.28989 | -1.56322 | 25.5731 | -42.9235 |
| 8 | 3.2988 | -1.49085 | 27.7957 | -47.8415 |
| 9 | 3.2988 | -1.4325 | 29.8478 | -52.5671 |
| 10 | 3.30285 | -1.3722 | 31.7308 | -57.0993 |
| 11 | 3.31091 | -1.31652 | 33.464 | -61.4581 |
| 12 | 3.31491 | -1.27024 | 35.0775 | -65.6689 |
| 13 | 3.32719 | -1.22123 | 36.5689 | -69.7321 |
| 14 | 3.33113 | -1.18 | 37.9613 | -73.6629 |
| 15 | 3.33149 | -1.1359 | 39.2515 | -77.4471 |
| 16 | 3.33256 | -1.09847 | 40.4582 | -81.1078 |
| 17 | 3.33328 | -1.05812 | 41.5778 | -84.6348 |
| 18 | 3.33613 | -1.02365 | 42.6257 | -88.0498 |
| 19 | 3.33968 | -0.986272 | 43.5984 | -91.3437 |
| 20 | 3.3418 | -0.954165 | 44.5088 | -94.5323 |
| 21 | 3.34392 | -0.919183 | 45.3537 | -97.606 |
| 22 | 3.34815 | -0.885291 | 46.1375 | -100.57 |
| 23 | 3.35201 | -0.855996 | 46.8702 | -103.439 |
| 24 | 3.3728 | -0.823893 | 47.549 | -106.218 |
| 25 | 3.37348 | -0.796056 | 48.1827 | -108.904 |
| 26 | 3.37656 | -0.765456 | 48.7686 | -111.488 |
| 27 | 3.37929 | -0.738846 | 49.3145 | -113.985 |
| 28 | 3.38031 | -0.709522 | 49.8179 | -116.383 |
| 29 | 3.38031 | -0.68396 | 50.2857 | -118.695 |
| 30 | 3.38507 | -0.655726 | 50.7157 | -120.915 |
| 31 | 3.38507 | -0.631062 | 51.114 | -123.051 |
| 32 | 3.39618 | -0.603765 | 51.4785 | -125.102 |
| 33 | 3.40983 | -0.576911 | 51.8113 | -127.069 |
| 34 | 3.46292 | -0.553384 | 52.1175 | -128.985 |
| 35 | 3.4886 | -0.52728 | 52.3956 | -130.825 |
| 36 | 3.49134 | -0.504372 | 52.65 | -132.586 |
| 37 | 3.5476 | -0.478914 | 52.8793 | -134.285 |
| 38 | 3.55392 | -0.456542 | 53.0877 | -135.907 |
| 39 | 3.56048 | -0.431644 | 53.2741 | -137.444 |
| 40 | 3.57487 | -0.409735 | 53.4419 | -138.909 |
| 41 | 3.58712 | -0.385321 | 53.5904 | -140.291 |
| 42 | 3.61281 | -0.363809 | 53.7228 | -141.605 |
| 43 | 3.63521 | -0.33981 | 53.8382 | -142.841 |
| 44 | 3.6504 | -0.316004 | 53.9381 | -143.994 |
| 45 | 3.66407 | -0.294992 | 54.0251 | -145.075 |
| 46 | 3.67021 | -0.271509 | 54.0988 | -146.072 |
| 47 | 3.69337 | -0.250759 | 54.1617 | -146.998 |
| 48 | 3.6961 | -0.227545 | 54.2135 | -147.839 |
| 49 | 3.7281 | -0.207012 | 54.2564 | -148.611 |
| 50 | 3.73457 | -0.184017 | 54.2902 | -149.298 |
| 51 | 3.74266 | -0.163659 | 54.317 | -149.91 |
| 52 | 3.75185 | -0.140835 | 54.3368 | -150.439 |
| 53 | 3.75887 | -0.12061 | 54.3514 | -150.892 |
| 54 | 3.76073 | -0.0979139 | 54.361 | -151.26 |
| 55 | 3.781 | -0.0752698 | 54.3666 | -151.545 |
| 56 | 3.78191 | -0.0551734 | 54.3697 | -151.754 |
| 57 | 3.78986 | -0.0325917 | 54.3707 | -151.877 |
| 58 | 3.80844 | -0.0125328 | 54.3709 | -151.925 |
| 59 | 3.80977 | 0.0125328 | 54.3711 | -151.877 |
| 60 | 3.86199 | 0.0325917 | 54.3721 | -151.751 |
| 61 | 3.86912 | 0.0551734 | 54.3752 | -151.538 |
| 62 | 3.87888 | 0.0752698 | 54.3808 | -151.246 |
| 63 | 3.88547 | 0.0979139 | 54.3904 | -150.865 |
| 64 | 3.89264 | 0.12061 | 54.405 | -150.396 |
| 65 | 3.919 | 0.140835 | 54.4248 | -149.844 |

## Shapiro-Francia Test of Normality (Continued)

**Parameter: Sulfate**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 51.91 | 0.163659 | 54.4516 | -1270.12 |
| 67 | 54.32 | 0.184017 | 54.4854 | -1260.13 |
| 68 | 55.4 | 0.207012 | 54.5283 | -1248.66 |
| 69 | 57.01 | 0.227545 | 54.5801 | -1235.69 |
| 70 | 58.18 | 0.250759 | 54.643 | -1221.1 |
| 71 | 59.08 | 0.271509 | 54.7167 | -1205.06 |
| 72 | 60.61 | 0.294992 | 54.8037 | -1187.18 |
| 73 | 63.05 | 0.316004 | 54.9036 | -1167.25 |
| 74 | 75.4 | 0.33981 | 55.019 | -1141.63 |
| 75 | 188.09 | 0.363809 | 55.1514 | -1073.2 |
| 76 | 190.52 | 0.385321 | 55.2999 | -999.792 |
| 77 | 195.22 | 0.409735 | 55.4677 | -919.804 |
| 78 | 202.08 | 0.431644 | 55.6541 | -832.577 |
| 79 | 205.86 | 0.456542 | 55.8625 | -738.593 |
| 80 | 213.97 | 0.478914 | 56.0918 | -636.12 |
| 81 | 225.43 | 0.504372 | 56.3462 | -522.42 |
| 82 | 226.96 | 0.52728 | 56.6243 | -402.748 |
| 83 | 229.35 | 0.553384 | 56.9305 | -275.829 |
| 84 | 231.36 | 0.576911 | 57.2633 | -142.355 |
| 85 | 232.5 | 0.603765 | 57.6278 | -1.9801 |
| 86 | 243.27 | 0.631062 | 58.0261 | 151.538 |
| 87 | 244.85 | 0.655726 | 58.4561 | 312.093 |
| 88 | 248.1 | 0.68396 | 58.9239 | 481.784 |
| 89 | 250.77 | 0.709522 | 59.4273 | 659.71 |
| 90 | 251.7 | 0.738846 | 59.9732 | 845.678 |
| 91 | 251.83 | 0.765456 | 60.5591 | 1038.44 |
| 92 | 259.44 | 0.796056 | 61.1928 | 1244.97 |
| 93 | 261.61 | 0.823893 | 61.8716 | 1460.51 |
| 94 | 264.57 | 0.855996 | 62.6043 | 1686.98 |
| 95 | 271.75 | 0.885291 | 63.3881 | 1927.56 |
| 96 | 274.52 | 0.919183 | 64.233 | 2179.89 |
| 97 | 282.18 | 0.954165 | 65.1434 | 2449.14 |
| 98 | 288.57 | 0.986272 | 66.1161 | 2733.75 |
| 99 | 293 | 1.02365 | 67.164 | 3033.68 |
| 100 | 293.23 | 1.05812 | 68.2836 | 3343.95 |
| 101 | 303.44 | 1.09847 | 69.4903 | 3677.27 |
| 102 | 307.72 | 1.1359 | 70.7805 | 4026.81 |
| 103 | 314.66 | 1.18 | 72.1729 | 4398.11 |
| 104 | 316.2 | 1.22123 | 73.6643 | 4784.26 |
| 105 | 318.47 | 1.27024 | 75.2778 | 5188.79 |
| 106 | 319.74 | 1.31652 | 77.011 | 5609.74 |
| 107 | 340.54 | 1.3722 | 78.894 | 6077.03 |
| 108 | 343.67 | 1.4325 | 80.9461 | 6569.34 |
| 109 | 348.11 | 1.49085 | 83.1687 | 7088.32 |
| 110 | 357.08 | 1.56322 | 85.6124 | 7646.51 |
| 111 | 361.85 | 1.63524 | 88.2864 | 8238.22 |
| 112 | 369.63 | 1.72793 | 91.2721 | 8876.92 |
| 113 | 382.44 | 1.82501 | 94.6027 | 9574.87 |
| 114 | 390.65 | 1.95996 | 98.4442 | 10340.5 |
| 115 | 405.72 | 2.12007 | 102.939 | 11200.7 |
| 116 | 439.51 | 2.40892 | 108.742 | 12259.4 |

Data Set Standard Deviation = 125.28
Numerator = 1.50294e+008
Denominator = 1.96271e+008
W Statistic = 0.765744 = 1.50294e+008 / 1.96271e+008

5% Critical value of 0.976 exceeds 0.765744
Evidence of non-normality at 95% level of significance

**Shapiro-Francia Test of Normality**
**Parameter: Sulfate**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 23.76 | -2.40892 | 5.80292 | -57.236 |
| 2 | 25.4 | -2.12007 | 10.2976 | -111.086 |
| 3 | 25.64 | -1.95996 | 14.1391 | -161.339 |
| 4 | 25.83 | -1.82501 | 17.4697 | -208.479 |
| 5 | 26.2 | -1.72793 | 20.4554 | -253.751 |
| 6 | 26.45 | -1.63524 | 23.1294 | -297.003 |
| 7 | 26.84 | -1.56322 | 25.5731 | -338.96 |
| 8 | 27.08 | -1.49085 | 27.7957 | -379.332 |
| 9 | 27.08 | -1.4325 | 29.8478 | -418.124 |
| 10 | 27.19 | -1.3722 | 31.7308 | -455.434 |
| 11 | 27.41 | -1.31652 | 33.464 | -491.52 |
| 12 | 27.52 | -1.27024 | 35.0775 | -526.477 |
| 13 | 27.86 | -1.22123 | 36.5689 | -560.501 |
| 14 | 27.97 | -1.18 | 37.9613 | -593.505 |
| 15 | 27.98 | -1.1359 | 39.2515 | -625.288 |
| 16 | 28.01 | -1.09847 | 40.4582 | -656.056 |
| 17 | 28.03 | -1.05812 | 41.5778 | -685.715 |
| 18 | 28.11 | -1.02365 | 42.6257 | -714.49 |
| 19 | 28.21 | -0.986272 | 43.5984 | -742.312 |
| 20 | 28.27 | -0.954165 | 44.5088 | -769.287 |
| 21 | 28.33 | -0.919183 | 45.3537 | -795.327 |
| 22 | 28.45 | -0.885291 | 46.1375 | -820.514 |
| 23 | 28.56 | -0.855996 | 46.8702 | -844.961 |
| 24 | 29.16 | -0.823893 | 47.549 | -868.986 |
| 25 | 29.18 | -0.796056 | 48.1827 | -892.215 |
| 26 | 29.27 | -0.765456 | 48.7686 | -914.619 |
| 27 | 29.35 | -0.738846 | 49.3145 | -936.305 |
| 28 | 29.38 | -0.709522 | 49.8179 | -957.15 |
| 29 | 29.38 | -0.68396 | 50.2857 | -977.245 |
| 30 | 29.52 | -0.655726 | 50.7157 | -996.602 |
| 31 | 29.52 | -0.631062 | 51.114 | -1015.23 |
| 32 | 29.85 | -0.603765 | 51.4785 | -1033.25 |
| 33 | 30.26 | -0.576911 | 51.8113 | -1050.71 |
| 34 | 31.91 | -0.553384 | 52.1175 | -1068.37 |
| 35 | 32.74 | -0.52728 | 52.3956 | -1085.63 |
| 36 | 32.83 | -0.504372 | 52.65 | -1102.19 |
| 37 | 34.73 | -0.478914 | 52.8793 | -1118.82 |
| 38 | 34.95 | -0.456542 | 53.0877 | -1134.78 |
| 39 | 35.18 | -0.431644 | 53.2741 | -1149.97 |
| 40 | 35.69 | -0.409735 | 53.4419 | -1164.59 |
| 41 | 36.13 | -0.385321 | 53.5904 | -1178.51 |
| 42 | 37.07 | -0.363809 | 53.7228 | -1192 |
| 43 | 37.91 | -0.33981 | 53.8382 | -1204.88 |
| 44 | 38.49 | -0.316004 | 53.9381 | -1217.04 |
| 45 | 39.02 | -0.294992 | 54.0251 | -1228.55 |
| 46 | 39.26 | -0.271509 | 54.0988 | -1239.21 |
| 47 | 40.18 | -0.250759 | 54.1617 | -1249.29 |
| 48 | 40.29 | -0.227545 | 54.2135 | -1258.46 |
| 49 | 41.6 | -0.207012 | 54.2564 | -1267.07 |
| 50 | 41.87 | -0.184017 | 54.2902 | -1274.77 |
| 51 | 42.21 | -0.163659 | 54.317 | -1281.68 |
| 52 | 42.6 | -0.140835 | 54.3368 | -1287.68 |
| 53 | 42.9 | -0.12061 | 54.3514 | -1292.85 |
| 54 | 42.98 | -0.0979139 | 54.361 | -1297.06 |
| 55 | 43.86 | -0.0752698 | 54.3666 | -1300.36 |
| 56 | 43.9 | -0.0551734 | 54.3697 | -1302.79 |
| 57 | 44.25 | -0.0325917 | 54.3707 | -1304.23 |
| 58 | 45.08 | -0.0125328 | 54.3709 | -1304.79 |
| 59 | 45.14 | 0.0125328 | 54.3711 | -1304.23 |
| 60 | 47.56 | 0.0325917 | 54.3721 | -1302.68 |
| 61 | 47.9 | 0.0551734 | 54.3752 | -1300.03 |
| 62 | 48.37 | 0.0752698 | 54.3808 | -1296.39 |
| 63 | 48.69 | 0.0979139 | 54.3904 | -1291.63 |
| 64 | 49.04 | 0.12061 | 54.405 | -1285.71 |
| 65 | 50.35 | 0.140835 | 54.4248 | -1278.62 |

**Rosner's Test for Outliers (Continued)**
**Parameter: Sulfate**
**Background Locations**
**Original Data (Not Transformed)**

--------------------------------------------
Iteration i = 3
Mean of 113 measurements = 119.248
Std Dev = 117.765
x(i+1) = 382.44 from measurement 10/2/2003 from location B-52
Rosner Statistic R = |382.44 - 119.248|/117.765 = 2.23489
Lambda(116, 4, 0.05) = 3.4148
2.23489 < 3.4148 -- No outliers detected for i = 3

--------------------------------------------
Iteration i = 2
Mean of 114 measurements = 121.628
Std Dev = 119.967
x(i+1) = 390.65 from measurement 10/2/2002 from location B-52
Rosner Statistic R = |390.65 - 121.628|/119.967 = 2.24247
Lambda(116, 3, 0.05) = 3.4216
2.24247 < 3.4216 -- No outliers detected for i = 2

--------------------------------------------
Iteration i = 1
Mean of 115 measurements = 124.099
Std Dev = 122.342
x(i+1) = 405.72 from measurement 10/13/2005 from location B-52
Rosner Statistic R = |405.72 - 124.099|/122.342 = 2.30192
Lambda(116, 2, 0.05) = 3.4216
2.30192 < 3.4216 -- No outliers detected for i = 1

--------------------------------------------
Iteration i = 0
Mean of 116 measurements = 126.818
Std Dev = 125.28
x(i+1) = 439.51 from measurement 7/27/2005 from location B-52
Rosner Statistic R = |439.51 - 126.818|/125.28 = 2.49595
Lambda(116, 1, 0.05) = 3.4248
2.49595 < 3.4248 -- No outliers detected for i = 0

**NO OUTLIERS DETECTED**

**Rosner's Test for Outliers**
**Parameter: Sulfate**
**Background Locations**
**Original Data (Not Transformed)**

Data set mean = 126.818

10 most extreme of 116 measurements
by order of magnitude difference from the mean

| | | | | |
|---|---|---|---|---|
| 1 | 7/27/2005 | B-52 | 439.51 | 312.692 |
| 2 | 10/13/2005 | B-52 | 405.72 | 278.902 |
| 3 | 10/2/2002 | B-52 | 390.65 | 263.832 |
| 4 | 10/2/2003 | B-52 | 382.44 | 255.622 |
| 5 | 4/3/2002 | B-52 | 369.63 | 242.812 |
| 6 | 1/8/2003 | B-52 | 361.85 | 235.032 |
| 7 | 1/5/2006 | B-52 | 357.08 | 230.262 |
| 8 | 7/23/2003 | B-52 | 348.11 | 221.292 |
| 9 | 4/8/2009 | B-52 | 343.67 | 216.852 |
| 10 | 7/13/2004 | B-52 | 340.54 | 213.722 |

--------------------------------------------

Iteration i = 9
Mean of 107 measurements = 105.721
Std Dev = 105.669
x(i+1) = 340.54 from measurement 7/13/2004 from location B-52
Rosner Statistic R = |340.54 - 105.721|/105.669 = 2.22222
Lambda(116, 10, 0.05) = 3.398
2.22222 < 3.398 -- No outliers detected for i = 9

--------------------------------------------

Iteration i = 8
Mean of 108 measurements = 107.925
Std Dev = 107.637
x(i+1) = 343.67 from measurement 4/8/2009 from location B-52
Rosner Statistic R = |343.67 - 107.925|/107.637 = 2.19018
Lambda(116, 9, 0.05) = 3.40136
2.19018 < 3.40136 -- No outliers detected for i = 8

--------------------------------------------

Iteration i = 7
Mean of 109 measurements = 110.128
Std Dev = 109.58
x(i+1) = 348.11 from measurement 7/23/2003 from location B-52
Rosner Statistic R = |348.11 - 110.128|/109.58 = 2.17177
Lambda(116, 8, 0.05) = 3.40472
2.17177 < 3.40472 -- No outliers detected for i = 7

--------------------------------------------

Iteration i = 6
Mean of 110 measurements = 112.373
Std Dev = 111.589
x(i+1) = 357.08 from measurement 1/5/2006 from location B-52
Rosner Statistic R = |357.08 - 112.373|/111.589 = 2.19294
Lambda(116, 7, 0.05) = 3.40808
2.19294 < 3.40808 -- No outliers detected for i = 6

--------------------------------------------

Iteration i = 5
Mean of 111 measurements = 114.621
Std Dev = 113.576
x(i+1) = 361.85 from measurement 1/8/2003 from location B-52
Rosner Statistic R = |361.85 - 114.621|/113.576 = 2.17677
Lambda(116, 6, 0.05) = 3.41144
2.17677 < 3.41144 -- No outliers detected for i = 5

--------------------------------------------

Iteration i = 4
Mean of 112 measurements = 116.898
Std Dev = 115.602
x(i+1) = 369.63 from measurement 4/3/2002 from location B-52
Rosner Statistic R = |369.63 - 116.898|/115.602 = 2.18622
Lambda(116, 5, 0.05) = 3.4148
2.18622 < 3.4148 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Sulfate
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| | | | 10/22/2008 | 28.03 | 28.03 |
| | | | 1/13/2009 | 27.52 | 27.52 |
| | | | 4/8/2009 | 29.35 | 29.35 |
| | | | 7/15/2009 | 28.56 | 28.56 |
| | | | 1/7/2010 | 25.83 | 25.83 |
| | | | 4/7/2010 | 27.08 | 27.08 |
| | | | 7/7/2010 | 26.84 | 26.84 |
| | | | 8/16/2011 | 27.97 | 27.97 |
| | | | 10/26/2011 | 27.41 | 27.41 |
| B-50 | 42 | 0 (0%) | 11/15/2001 | 75.4 | 75.4 |
| | | | 1/16/2002 | 47.56 | 47.56 |
| | | | 4/3/2002 | 50.35 | 50.35 |
| | | | 7/2/2002 | 41.87 | 41.87 |
| | | | 10/2/2002 | 39.02 | 39.02 |
| | | | 1/8/2003 | 34.73 | 34.73 |
| | | | 4/2/2003 | 35.18 | 35.18 |
| | | | 7/23/2003 | 44.25 | 44.25 |
| | | | 10/2/2003 | 43.9 | 43.9 |
| | | | 1/7/2004 | 48.69 | 48.69 |
| | | | 4/7/2004 | 60.61 | 60.61 |
| | | | 7/13/2004 | 51.91 | 51.91 |
| | | | 10/6/2004 | 49.04 | 49.04 |
| | | | 1/6/2005 | 59.08 | 59.08 |
| | | | 4/6/2005 | 57.01 | 57.01 |
| | | | 7/27/2005 | 54.32 | 54.32 |
| | | | 10/13/2005 | 58.18 | 58.18 |
| | | | 1/5/2006 | 63.05 | 63.05 |
| | | | 4/6/2006 | 45.08 | 45.08 |
| | | | 7/25/2006 | 47.9 | 47.9 |
| | | | 10/11/2006 | 43.86 | 43.86 |
| | | | 1/4/2007 | 42.98 | 42.98 |
| | | | 4/4/2007 | 42.21 | 42.21 |
| | | | 7/12/2007 | 42.6 | 42.6 |
| | | | 10/10/2007 | 40.18 | 40.18 |
| | | | 1/16/2008 | 48.37 | 48.37 |
| | | | 4/3/2008 | 41.6 | 41.6 |
| | | | 7/23/2008 | 37.91 | 37.91 |
| | | | 10/22/2008 | 37.07 | 37.07 |
| | | | 1/13/2009 | 42.9 | 42.9 |
| | | | 4/8/2009 | 35.69 | 35.69 |
| | | | 7/15/2009 | 34.95 | 34.95 |
| | | | 10/8/2009 | 39.26 | 39.26 |
| | | | 1/7/2010 | 29.85 | 29.85 |
| | | | 4/7/2010 | 29.52 | 29.52 |
| | | | 7/7/2010 | 29.38 | 29.38 |
| | | | 12/8/2010 | 36.13 | 36.13 |
| | | | 2/3/2011 | 38.49 | 38.49 |
| | | | 4/13/2011 | 32.74 | 32.74 |
| | | | 8/16/2011 | 32.83 | 32.83 |
| | | | 10/26/2011 | 40.29 | 40.29 |
| | | | 1/18/2012 | 45.14 | 45.14 |

## Concentrations (mg/L)

**Parameter: Sulfate**
**Original Data (Not Transformed)**
**Percent Background Non-Detects: 0%**
**Total Background Measurements: 116**
**There are 3 background locations**

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-52 | 42 | 0 (0%) | 11/15/2001 | 190.52 | 190.52 |
| | | | 1/16/2002 | 251.83 | 251.83 |
| | | | 4/3/2002 | 369.63 | 369.63 |
| | | | 7/2/2002 | 314.66 | 314.66 |
| | | | 10/2/2002 | 390.65 | 390.65 |
| | | | 1/8/2003 | 361.85 | 361.85 |
| | | | 4/2/2003 | 202.08 | 202.08 |
| | | | 7/23/2003 | 348.11 | 348.11 |
| | | | 10/2/2003 | 382.44 | 382.44 |
| | | | 1/7/2004 | 248.1 | 248.1 |
| | | | 4/7/2004 | 213.97 | 213.97 |
| | | | 7/13/2004 | 340.54 | 340.54 |
| | | | 10/6/2004 | 261.61 | 261.61 |
| | | | 1/6/2005 | 195.22 | 195.22 |
| | | | 4/6/2005 | 225.43 | 225.43 |
| | | | 7/27/2005 | 439.51 | 439.51 |
| | | | 10/13/2005 | 405.72 | 405.72 |
| | | | 1/5/2006 | 357.08 | 357.08 |
| | | | 4/6/2006 | 251.7 | 251.7 |
| | | | 7/25/2006 | 274.52 | 274.52 |
| | | | 10/11/2006 | 319.74 | 319.74 |
| | | | 1/4/2007 | 205.86 | 205.86 |
| | | | 4/4/2007 | 264.57 | 264.57 |
| | | | 7/12/2007 | 229.35 | 229.35 |
| | | | 10/10/2007 | 250.77 | 250.77 |
| | | | 1/16/2008 | 259.44 | 259.44 |
| | | | 4/3/2008 | 282.18 | 282.18 |
| | | | 7/23/2008 | 232.5 | 232.5 |
| | | | 10/22/2008 | 243.27 | 243.27 |
| | | | 1/13/2009 | 244.85 | 244.85 |
| | | | 4/8/2009 | 343.67 | 343.67 |
| | | | 7/15/2009 | 293 | 293 |
| | | | 10/8/2009 | 271.75 | 271.75 |
| | | | 1/7/2010 | 318.47 | 318.47 |
| | | | 4/7/2010 | 288.57 | 288.57 |
| | | | 7/7/2010 | 231.36 | 231.36 |
| | | | 12/8/2010 | 303.44 | 303.44 |
| | | | 2/3/2011 | 307.72 | 307.72 |
| | | | 4/13/2011 | 293.23 | 293.23 |
| | | | 8/16/2011 | 316.2 | 316.2 |
| | | | 10/26/2011 | 188.09 | 188.09 |
| | | | 1/18/2012 | 226.96 | 226.96 |
| B-51 | 32 | 0 (0%) | 11/15/2001 | 25.4 | 25.4 |
| | | | 10/2/2002 | 55.4 | 55.4 |
| | | | 1/8/2003 | 31.91 | 31.91 |
| | | | 4/2/2003 | 28.27 | 28.27 |
| | | | 7/23/2003 | 26.2 | 26.2 |
| | | | 10/2/2003 | 25.64 | 25.64 |
| | | | 1/7/2004 | 28.21 | 28.21 |
| | | | 4/7/2004 | 27.86 | 27.86 |
| | | | 7/13/2004 | 30.26 | 30.26 |
| | | | 10/6/2004 | 27.19 | 27.19 |
| | | | 1/6/2005 | 29.18 | 29.18 |
| | | | 4/6/2005 | 29.16 | 29.16 |
| | | | 7/27/2005 | 27.98 | 27.98 |
| | | | 10/13/2005 | 27.08 | 27.08 |
| | | | 1/5/2006 | 23.76 | 23.76 |
| | | | 4/6/2006 | 28.45 | 28.45 |
| | | | 7/25/2006 | 28.33 | 28.33 |
| | | | 10/11/2006 | 26.45 | 26.45 |
| | | | 1/4/2007 | 29.27 | 29.27 |
| | | | 4/4/2007 | 29.52 | 29.52 |
| | | | 7/12/2007 | 29.38 | 29.38 |
| | | | 10/10/2007 | 28.11 | 28.11 |
| | | | 7/23/2008 | 28.01 | 28.01 |

**Non-Parametric Prediction Interval**
**Inter-Well Comparison**
**Parameter: Chloride**
**Original Data (Not Transformed)**

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
**Maximum Background Value = 30.37**
Confidence Level = 99%
False Positive Rate = 1%

| Location | Date | Count | Mean | Significant |
|---|---|---|---|---|
| B-30A | 4/4/2012 | 1 | 9.41 | FALSE |
| B-32 | 4/4/2012 | 1 | 18 | FALSE |
| B-31 | 4/4/2012 | 1 | 2.75 | FALSE |
| DM-1 | 4/4/2012 | 1 | 7 | FALSE |
| DM-7 | 4/4/2012 | 1 | 6.89 | FALSE |
| DM-6 | 4/4/2012 | 1 | 3.64 | FALSE |
| DM-5 | 4/4/2012 | 1 | 19.09 | FALSE |

**Shapiro-Francia Test of Normality (Continued)**
**Parameter: Chloride**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Natural Logarithm Transformation**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 2.98265 | 0.163659 | 54.4516 | -93.1108 |
| 67 | 2.98619 | 0.184017 | 54.4854 | -92.5613 |
| 68 | 2.98871 | 0.207012 | 54.5283 | -91.9426 |
| 69 | 2.99223 | 0.227545 | 54.5801 | -91.2617 |
| 70 | 3.01553 | 0.250759 | 54.643 | -90.5055 |
| 71 | 3.0282 | 0.271509 | 54.7167 | -89.6833 |
| 72 | 3.04118 | 0.294992 | 54.8037 | -88.7862 |
| 73 | 3.054 | 0.316004 | 54.9036 | -87.8211 |
| 74 | 3.06058 | 0.33981 | 55.019 | -86.7811 |
| 75 | 3.06199 | 0.363809 | 55.1514 | -85.6671 |
| 76 | 3.06433 | 0.385321 | 55.2999 | -84.4864 |
| 77 | 3.07038 | 0.409735 | 55.4677 | -83.2283 |
| 78 | 3.09195 | 0.431644 | 55.6541 | -81.8937 |
| 79 | 3.09286 | 0.456542 | 55.8625 | -80.4817 |
| 80 | 3.09784 | 0.478914 | 56.0918 | -78.9981 |
| 81 | 3.10548 | 0.504372 | 56.3462 | -77.4318 |
| 82 | 3.10906 | 0.52728 | 56.6243 | -75.7924 |
| 83 | 3.125 | 0.553384 | 56.9305 | -74.0631 |
| 84 | 3.12632 | 0.576911 | 57.2633 | -72.2595 |
| 85 | 3.13332 | 0.603765 | 57.6278 | -70.3677 |
| 86 | 3.14243 | 0.631062 | 58.0261 | -68.3847 |
| 87 | 3.14329 | 0.655726 | 58.4561 | -66.3235 |
| 88 | 3.17555 | 0.68396 | 58.9239 | -64.1516 |
| 89 | 3.1954 | 0.709522 | 59.4273 | -61.8844 |
| 90 | 3.20112 | 0.738846 | 59.9732 | -59.5192 |
| 91 | 3.20761 | 0.765456 | 60.5591 | -57.0639 |
| 92 | 3.22008 | 0.796056 | 61.1928 | -54.5006 |
| 93 | 3.22127 | 0.823893 | 61.8716 | -51.8466 |
| 94 | 3.22724 | 0.855996 | 62.6043 | -49.0841 |
| 95 | 3.23475 | 0.885291 | 63.3881 | -46.2204 |
| 96 | 3.24298 | 0.919183 | 64.233 | -43.2395 |
| 97 | 3.24454 | 0.954165 | 65.1434 | -40.1437 |
| 98 | 3.25037 | 0.986272 | 66.1161 | -36.9379 |
| 99 | 3.25963 | 1.02365 | 67.164 | -33.6012 |
| 100 | 3.2604 | 1.05812 | 68.2836 | -30.1513 |
| 101 | 3.26957 | 1.09847 | 69.4903 | -26.5598 |
| 102 | 3.27526 | 1.1359 | 70.7805 | -22.8394 |
| 103 | 3.28016 | 1.18 | 72.1729 | -18.9688 |
| 104 | 3.28129 | 1.22123 | 73.6643 | -14.9616 |
| 105 | 3.28279 | 1.27024 | 75.2778 | -10.7917 |
| 106 | 3.28915 | 1.31652 | 77.011 | -6.46147 |
| 107 | 3.30138 | 1.3722 | 78.894 | -1.93131 |
| 108 | 3.30762 | 1.4325 | 80.9461 | 2.80687 |
| 109 | 3.31127 | 1.49085 | 83.1687 | 7.74349 |
| 110 | 3.312 | 1.56322 | 85.6124 | 12.9209 |
| 111 | 3.32611 | 1.63524 | 88.2864 | 18.3599 |
| 112 | 3.33256 | 1.72793 | 91.2721 | 24.1183 |
| 113 | 3.34145 | 1.82501 | 94.6027 | 30.2165 |
| 114 | 3.3555 | 1.95996 | 98.4442 | 36.7931 |
| 115 | 3.35899 | 2.12007 | 102.939 | 43.9144 |
| 116 | 3.41346 | 2.40892 | 108.742 | 52.1371 |

Data Set Standard Deviation = 0.496211
Numerator = 2718.28
Denominator = 3079.12
W Statistic = 0.88281 = 2718.28 / 3079.12

5% Critical value of 0.976 exceeds 0.88281
Evidence of non-normality at 95% level of significance

## Shapiro-Francia Test of Normality

**Parameter: Chloride**

**Background Locations**

**Normality Test of Parameter Concentrations**

**Natural Logarithm Transformation**

**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 1.83737 | -2.40892 | 5.80292 | -4.42608 |
| 2 | 1.90509 | -2.12007 | 10.2976 | -8.465 |
| 3 | 1.95727 | -1.95996 | 14.1391 | -12.3012 |
| 4 | 1.96009 | -1.82501 | 17.4697 | -15.8784 |
| 5 | 1.96571 | -1.72793 | 20.4554 | -19.275 |
| 6 | 1.99334 | -1.63524 | 23.1294 | -22.5346 |
| 7 | 2.05796 | -1.56322 | 25.5731 | -25.7516 |
| 8 | 2.05924 | -1.49085 | 27.7957 | -28.8216 |
| 9 | 2.05924 | -1.4325 | 29.8478 | -31.7715 |
| 10 | 2.06433 | -1.3722 | 31.7308 | -34.6042 |
| 11 | 2.07191 | -1.31652 | 33.464 | -37.3319 |
| 12 | 2.08691 | -1.27024 | 35.0775 | -39.9828 |
| 13 | 2.08815 | -1.22123 | 36.5689 | -42.5329 |
| 14 | 2.08815 | -1.18 | 37.9613 | -44.9969 |
| 15 | 2.10169 | -1.1359 | 39.2515 | -47.3842 |
| 16 | 2.10535 | -1.09847 | 40.4582 | -49.6969 |
| 17 | 2.11384 | -1.05812 | 41.5778 | -51.9336 |
| 18 | 2.11986 | -1.02365 | 42.6257 | -54.1036 |
| 19 | 2.12106 | -0.986272 | 43.5984 | -56.1955 |
| 20 | 2.12465 | -0.954165 | 44.5088 | -58.2228 |
| 21 | 2.12585 | -0.919183 | 45.3537 | -60.1768 |
| 22 | 2.12704 | -0.885291 | 46.1375 | -62.0599 |
| 23 | 2.13889 | -0.855996 | 46.8702 | -63.8908 |
| 24 | 2.14124 | -0.823893 | 47.549 | -65.6549 |
| 25 | 2.14476 | -0.796056 | 48.1827 | -67.3623 |
| 26 | 2.14476 | -0.765456 | 48.7686 | -69.004 |
| 27 | 2.14943 | -0.738846 | 49.3145 | -70.5921 |
| 28 | 2.15176 | -0.709522 | 49.8179 | 72.1188 |
| 29 | 2.15292 | -0.68396 | 50.2857 | -73.5913 |
| 30 | 2.15409 | -0.655726 | 50.7157 | -75.0038 |
| 31 | 2.15871 | -0.631062 | 51.114 | -76.3661 |
| 32 | 2.16102 | -0.603765 | 51.4785 | -77.6709 |
| 33 | 2.16791 | -0.576911 | 51.8113 | -78.9215 |
| 34 | 2.16791 | -0.553384 | 52.1175 | -80.1212 |
| 35 | 2.17929 | -0.52728 | 52.3956 | -81.2703 |
| 36 | 2.18605 | -0.504372 | 52.65 | -82.3729 |
| 37 | 2.18717 | -0.478914 | 52.8793 | -83.4204 |
| 38 | 2.19389 | -0.456542 | 53.0877 | -84.422 |
| 39 | 2.20827 | -0.431644 | 53.2741 | -85.3752 |
| 40 | 2.23431 | -0.409735 | 53.4419 | -86.2906 |
| 41 | 2.28646 | -0.385321 | 53.5904 | -87.1717 |
| 42 | 2.3263 | -0.363809 | 53.7228 | -88.018 |
| 43 | 2.37955 | -0.33981 | 53.8382 | -88.8266 |
| 44 | 2.3988 | -0.316004 | 53.9381 | -89.5846 |
| 45 | 2.45531 | -0.294992 | 54.0251 | -90.3089 |
| 46 | 2.54475 | -0.271509 | 54.0988 | -90.9998 |
| 47 | 2.54553 | -0.250759 | 54.1617 | -91.6381 |
| 48 | 2.55645 | -0.227545 | 54.2135 | -92.2199 |
| 49 | 2.59525 | -0.207012 | 54.2564 | -92.7571 |
| 50 | 2.65886 | -0.184017 | 54.2902 | -93.2464 |
| 51 | 2.72392 | -0.163659 | 54.317 | 93.6922 |
| 52 | 2.74019 | -0.140835 | 54.3368 | -94.0781 |
| 53 | 2.76506 | -0.12061 | 54.3514 | -94.4116 |
| 54 | 2.76946 | -0.0979139 | 54.361 | -94.6828 |
| 55 | 2.78068 | -0.0752698 | 54.3666 | -94.8921 |
| 56 | 2.78316 | -0.0551734 | 54.3697 | -95.0456 |
| 57 | 2.87582 | -0.0325917 | 54.3707 | -95.1393 |
| 58 | 2.8792 | -0.0125328 | 54.3709 | -95.1754 |
| 59 | 2.88032 | 0.0125328 | 54.3711 | -95.1393 |
| 60 | 2.88144 | 0.0325917 | 54.3721 | -95.0454 |
| 61 | 2.88536 | 0.0551734 | 54.3752 | -94.8862 |
| 62 | 2.93439 | 0.0752698 | 54.3808 | -94.6654 |
| 63 | 2.94286 | 0.0979139 | 54.3904 | -94.3772 |
| 64 | 2.97553 | 0.12061 | 54.405 | -94.0183 |
| 65 | 2.97808 | 0.140835 | 54.4248 | -93.5989 |

**Shapiro-Francia Test of Normality (Continued)**
**Parameter: Chloride**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 19.74 | 0.163659 | 54.4516 | -361.705 |
| 67 | 19.81 | 0.184017 | 54.4854 | -358.06 |
| 68 | 19.86 | 0.207012 | 54.5283 | -353.948 |
| 69 | 19.93 | 0.227545 | 54.5801 | -349.413 |
| 70 | 20.4 | 0.250759 | 54.643 | -344.298 |
| 71 | 20.66 | 0.271509 | 54.7167 | -338.688 |
| 72 | 20.93 | 0.294992 | 54.8037 | -332.514 |
| 73 | 21.2 | 0.316004 | 54.9036 | -325.815 |
| 74 | 21.34 | 0.33981 | 55.019 | -318.563 |
| 75 | 21.37 | 0.363809 | 55.1514 | -310.789 |
| 76 | 21.42 | 0.385321 | 55.2999 | -302.535 |
| 77 | 21.55 | 0.409735 | 55.4677 | -293.705 |
| 78 | 22.02 | 0.431644 | 55.6541 | -284.201 |
| 79 | 22.04 | 0.456542 | 55.8625 | -274.138 |
| 80 | 22.15 | 0.478914 | 56.0918 | -263.53 |
| 81 | 22.32 | 0.504372 | 56.3462 | -252.273 |
| 82 | 22.4 | 0.52728 | 56.6243 | -240.462 |
| 83 | 22.76 | 0.553384 | 56.9305 | -227.867 |
| 84 | 22.79 | 0.576911 | 57.2633 | -214.719 |
| 85 | 22.95 | 0.603765 | 57.6278 | -200.863 |
| 86 | 23.16 | 0.631062 | 58.0261 | -186.247 |
| 87 | 23.18 | 0.655726 | 58.4561 | -171.048 |
| 88 | 23.94 | 0.68396 | 58.9239 | -154.673 |
| 89 | 24.42 | 0.709522 | 59.4273 | -137.347 |
| 90 | 24.56 | 0.738846 | 59.9732 | -119.201 |
| 91 | 24.72 | 0.765456 | 60.5591 | -100.279 |
| 92 | 25.03 | 0.796056 | 61.1928 | -80.3536 |
| 93 | 25.06 | 0.823893 | 61.8716 | -59.7068 |
| 94 | 25.21 | 0.855996 | 62.6043 | -38.1271 |
| 95 | 25.4 | 0.885291 | 63.3881 | -15.6408 |
| 96 | 25.61 | 0.919183 | 64.233 | 7.89952 |
| 97 | 25.65 | 0.954165 | 65.1434 | 32.3738 |
| 98 | 25.8 | 0.986272 | 66.1161 | 57.8197 |
| 99 | 26.04 | 1.02365 | 67.164 | 84.4756 |
| 100 | 26.06 | 1.05812 | 68.2836 | 112.05 |
| 101 | 26.3 | 1.09847 | 69.4903 | 140.94 |
| 102 | 26.45 | 1.1359 | 70.7805 | 170.984 |
| 103 | 26.58 | 1.18 | 72.1729 | 202.349 |
| 104 | 26.61 | 1.22123 | 73.6643 | 234.846 |
| 105 | 26.65 | 1.27024 | 75.2778 | 268.698 |
| 106 | 26.82 | 1.31652 | 77.011 | 304.007 |
| 107 | 27.15 | 1.3722 | 78.894 | 341.262 |
| 108 | 27.32 | 1.4325 | 80.9461 | 380.398 |
| 109 | 27.42 | 1.49085 | 83.1687 | 421.277 |
| 110 | 27.44 | 1.56322 | 85.6124 | 464.172 |
| 111 | 27.83 | 1.63524 | 88.2864 | 509.681 |
| 112 | 28.01 | 1.72793 | 91.2721 | 558.08 |
| 113 | 28.26 | 1.82501 | 94.6027 | 609.655 |
| 114 | 28.66 | 1.95996 | 98.4442 | 665.827 |
| 115 | 28.76 | 2.12007 | 102.939 | 726.8 |
| 116 | 30.37 | 2.40892 | 108.742 | 799.959 |

Data Set Standard Deviation = 7.54895
Numerator = 639935
Denominator = 712636
W Statistic = 0.897983 = 639935 / 712636

5% Critical value of 0.976 exceeds 0.897983
Evidence of non-normality at 95% level of significance

## Shapiro-Francia Test of Normality

**Parameter: Chloride**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 6.28 | -2.40892 | 5.80292 | -15.128 |
| 2 | 6.72 | -2.12007 | 10.2976 | -29.3749 |
| 3 | 7.08 | -1.95996 | 14.1391 | -43.2514 |
| 4 | 7.1 | -1.82501 | 17.4697 | -56.209 |
| 5 | 7.14 | -1.72793 | 20.4554 | -68.5464 |
| 6 | 7.34 | -1.63524 | 23.1294 | -80.549 |
| 7 | 7.83 | -1.56322 | 25.5731 | -92.789 |
| 8 | 7.84 | -1.49085 | 27.7957 | -104.477 |
| 9 | 7.84 | -1.4325 | 29.8478 | -115.708 |
| 10 | 7.88 | -1.3722 | 31.7308 | -126.521 |
| 11 | 7.94 | -1.31652 | 33.464 | -136.974 |
| 12 | 8.06 | -1.27024 | 35.0775 | -147.212 |
| 13 | 8.07 | -1.22123 | 36.5689 | -157.068 |
| 14 | 8.07 | -1.18 | 37.9613 | -166.59 |
| 15 | 8.18 | -1.1359 | 39.2515 | -175.882 |
| 16 | 8.21 | -1.09847 | 40.4582 | -184.9 |
| 17 | 8.28 | -1.05812 | 41.5778 | -193.662 |
| 18 | 8.33 | -1.02365 | 42.6257 | -202.189 |
| 19 | 8.34 | -0.986272 | 43.5984 | -210.414 |
| 20 | 8.37 | -0.954165 | 44.5088 | -218.401 |
| 21 | 8.38 | -0.919183 | 45.3537 | -226.103 |
| 22 | 8.39 | -0.885291 | 46.1375 | -233.531 |
| 23 | 8.49 | -0.855996 | 46.8702 | -240.798 |
| 24 | 8.51 | -0.823893 | 47.549 | -247.81 |
| 25 | 8.54 | -0.796056 | 48.1827 | -254.608 |
| 26 | 8.54 | -0.765456 | 48.7686 | -261.145 |
| 27 | 8.58 | -0.738846 | 49.3145 | -267.484 |
| 28 | 8.6 | -0.709522 | 49.8179 | -273.586 |
| 29 | 8.61 | -0.68396 | 50.2857 | -279.475 |
| 30 | 8.62 | -0.655726 | 50.7157 | -285.127 |
| 31 | 8.66 | -0.631062 | 51.114 | -290.592 |
| 32 | 8.68 | -0.603765 | 51.4785 | -295.833 |
| 33 | 8.74 | -0.576911 | 51.8113 | -300.875 |
| 34 | 8.74 | -0.553384 | 52.1175 | -305.712 |
| 35 | 8.84 | -0.52728 | 52.3956 | -310.373 |
| 36 | 8.9 | -0.504372 | 52.65 | -314.862 |
| 37 | 8.91 | -0.478914 | 52.8793 | -319.129 |
| 38 | 8.97 | -0.456542 | 53.0877 | -323.224 |
| 39 | 9.1 | -0.431644 | 53.2741 | -327.152 |
| 40 | 9.34 | -0.409735 | 53.4419 | -330.979 |
| 41 | 9.84 | -0.385321 | 53.5904 | -334.771 |
| 42 | 10.24 | -0.363809 | 53.7228 | -338.496 |
| 43 | 10.8 | -0.33981 | 53.8382 | -342.166 |
| 44 | 11.01 | -0.316004 | 53.9381 | -345.645 |
| 45 | 11.65 | -0.294992 | 54.0251 | -349.082 |
| 46 | 12.74 | -0.271509 | 54.0988 | -352.541 |
| 47 | 12.75 | -0.250759 | 54.1617 | -355.738 |
| 48 | 12.89 | -0.227545 | 54.2135 | -358.671 |
| 49 | 13.4 | -0.207012 | 54.2564 | -361.445 |
| 50 | 14.28 | -0.184017 | 54.2902 | -364.073 |
| 51 | 15.24 | -0.163659 | 54.317 | -366.567 |
| 52 | 15.49 | -0.140835 | 54.3368 | -368.749 |
| 53 | 15.88 | -0.12061 | 54.3514 | -370.664 |
| 54 | 15.95 | -0.0979139 | 54.361 | -372.226 |
| 55 | 16.13 | -0.0752698 | 54.3666 | -373.44 |
| 56 | 16.17 | -0.0551734 | 54.3697 | -374.332 |
| 57 | 17.74 | -0.0325917 | 54.3707 | -374.91 |
| 58 | 17.8 | -0.0125328 | 54.3709 | -375.133 |
| 59 | 17.82 | 0.0125328 | 54.3711 | -374.91 |
| 60 | 17.84 | 0.0325917 | 54.3721 | -374.328 |
| 61 | 17.91 | 0.0551734 | 54.3752 | -373.34 |
| 62 | 18.81 | 0.0752698 | 54.3808 | -371.924 |
| 63 | 18.97 | 0.0979139 | 54.3904 | -370.067 |
| 64 | 19.6 | 0.12061 | 54.405 | -367.703 |
| 65 | 19.65 | 0.140835 | 54.4248 | -364.936 |

**Rosner's Test for Outliers**
**Parameter: Chloride**
**Background Locations**
**Original Data (Not Transformed)**

---

Iteration i = 3
Mean of 113 measurements = 16.4952
Std Dev = 7.36497
x(i+1) = 28.26 from measurement 10/11/2006 from location B-50
Rosner Statistic R = |28.26 - 16.4952|/7.36497 = 1.5974
Lambda(116, 4, 0.05) = 3.4148
1.5974 < 3.4148 -- No outliers detected for i = 3

---

Iteration i = 2
Mean of 114 measurements = 16.6019
Std Dev = 7.4203
x(i+1) = 28.66 from measurement 7/23/2008 from location B-51
Rosner Statistic R = |28.66 - 16.6019|/7.4203 = 1.62501
Lambda(116, 3, 0.05) = 3.4216
1.62501 < 3.4216 -- No outliers detected for i = 2

---

Iteration i = 1
Mean of 115 measurements = 16.7077
Std Dev = 7.47417
x(i+1) = 28.76 from measurement 10/26/2011 from location B-52
Rosner Statistic R = |28.76 - 16.7077|/7.47417 = 1.61253
Lambda(116, 2, 0.05) = 3.4216
1.61253 < 3.4216 -- No outliers detected for i = 1

---

Iteration i = 0
Mean of 116 measurements = 16.8254
Std Dev = 7.54895
x(i+1) = 30.37 from measurement 1/4/2007 from location B-50
Rosner Statistic R = |30.37 - 16.8254|/7.54895 = 1.79423
Lambda(116, 1, 0.05) = 3.4248
1.79423 < 3.4248 -- No outliers detected for i = 0

**NO OUTLIERS DETECTED**

**Rosner's Test for Outliers**
**Parameter: Chloride**
**Background Locations**
**Original Data (Not Transformed)**

Data set mean = 16.8254

10 most extreme of 116 measurements
by order of magnitude difference from the mean

| | | | | |
|---|---|---|---|---|
| 1 | 1/4/2007 | B-50 | 30.37 | 13.5446 |
| 2 | 10/26/2011 | B-52 | 28.76 | 11.9346 |
| 3 | 7/23/2008 | B-51 | 28.66 | 11.8346 |
| 4 | 10/11/2006 | B-50 | 28.26 | 11.4346 |
| 5 | 4/4/2007 | B-51 | 28.01 | 11.1846 |
| 6 | 7/27/2005 | B-51 | 27.83 | 11.0046 |
| 7 | 1/7/2010 | B-51 | 27.44 | 10.6146 |
| 8 | 10/13/2005 | B-51 | 27.42 | 10.5946 |
| 9 | 1/7/2004 | B-50 | 6.28 | 10.5454 |
| 10 | 10/11/2006 | B-51 | 27.32 | 10.4946 |

--------------------------------------------
Iteration i = 9
Mean of 107 measurements = 16.0628
Std Dev = 7.07922
x(i+1) = 27.32 from measurement 10/11/2006 from location B-51
Rosner Statistic R = |27.32 - 16.0628|/7.07922 = 1.59018
Lambda(116, 10, 0.05) = 3.398
1.59018 < 3.398 -- No outliers detected for i = 9

--------------------------------------------
Iteration i = 8
Mean of 108 measurements = 15.9722
Std Dev = 7.10866
x(i+1) = 6.28 from measurement 1/7/2004 from location B-50
Rosner Statistic R = |6.28 - 15.9722|/7.10866 = 1.36344
Lambda(116, 9, 0.05) = 3.40136
1.36344 < 3.40136 -- No outliers detected for i = 8

--------------------------------------------
Iteration i = 7
Mean of 109 measurements = 16.0772
Std Dev = 7.16013
x(i+1) = 27.42 from measurement 10/13/2005 from location B-51
Rosner Statistic R = |27.42 - 16.0772|/7.16013 = 1.58415
Lambda(116, 8, 0.05) = 3.40472
1.58415 < 3.40472 -- No outliers detected for i = 7

--------------------------------------------
Iteration i = 6
Mean of 110 measurements = 16.1805
Std Dev = 7.20908
x(i+1) = 27.44 from measurement 1/7/2010 from location B-51
Rosner Statistic R = |27.44 - 16.1805|/7.20908 = 1.56184
Lambda(116, 7, 0.05) = 3.40808
1.56184 < 3.40808 -- No outliers detected for i = 6

--------------------------------------------
Iteration i = 5
Mean of 111 measurements = 16.2855
Std Dev = 7.26093
x(i+1) = 27.83 from measurement 7/27/2005 from location B-51
Rosner Statistic R = |27.83 - 16.2855|/7.26093 = 1.58995
Lambda(116, 6, 0.05) = 3.41144
1.58995 < 3.41144 -- No outliers detected for i = 5

--------------------------------------------
Iteration i = 4
Mean of 112 measurements = 16.3902
Std Dev = 7.31255
x(i+1) = 28.01 from measurement 4/4/2007 from location B-51
Rosner Statistic R = |28.01 - 16.3902|/7.31255 = 1.58902
Lambda(116, 5, 0.05) = 3.4148
1.58902 < 3.4148 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
**Parameter: Chloride**
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| | | | 10/22/2008 | 26.58 | 26.58 |
| | | | 1/13/2009 | 25.65 | 25.65 |
| | | | 4/8/2009 | 26.06 | 26.06 |
| | | | 7/15/2009 | 25.21 | 25.21 |
| | | | 1/7/2010 | 27.44 | 27.44 |
| | | | 4/7/2010 | 25.61 | 25.61 |
| | | | 7/7/2010 | 24.42 | 24.42 |
| | | | 8/16/2011 | 22.95 | 22.95 |
| | | | 10/26/2011 | 20.93 | 20.93 |
| B-50 | 42 | 0 (0%) | 11/15/2001 | 15.49 | 15.49 |
| | | | 1/16/2002 | 21.2 | 21.2 |
| | | | 4/3/2002 | 20.4 | 20.4 |
| | | | 7/2/2002 | 17.84 | 17.84 |
| | | | 10/2/2002 | 17.8 | 17.8 |
| | | | 1/8/2003 | 15.88 | 15.88 |
| | | | 4/2/2003 | 7.1 | 7.1 |
| | | | 7/23/2003 | 12.75 | 12.75 |
| | | | 10/2/2003 | 12.89 | 12.89 |
| | | | 1/7/2004 | 6.28 | 6.28 |
| | | | 4/7/2004 | 10.8 | 10.8 |
| | | | 7/13/2004 | 11.65 | 11.65 |
| | | | 10/6/2004 | 12.74 | 12.74 |
| | | | 1/6/2005 | 7.84 | 7.84 |
| | | | 4/6/2005 | 15.95 | 15.95 |
| | | | 7/27/2005 | 18.81 | 18.81 |
| | | | 10/13/2005 | 22.02 | 22.02 |
| | | | 1/5/2006 | 19.65 | 19.65 |
| | | | 4/6/2006 | 21.42 | 21.42 |
| | | | 7/25/2006 | 24.56 | 24.56 |
| | | | 10/11/2006 | 28.26 | 28.26 |
| | | | 1/4/2007 | 30.37 | 30.37 |
| | | | 4/4/2007 | 25.8 | 25.8 |
| | | | 7/12/2007 | 23.16 | 23.16 |
| | | | 10/10/2007 | 22.4 | 22.4 |
| | | | 1/16/2008 | 23.18 | 23.18 |
| | | | 4/3/2008 | 19.81 | 19.81 |
| | | | 7/23/2008 | 17.74 | 17.74 |
| | | | 10/22/2008 | 16.17 | 16.17 |
| | | | 1/13/2009 | 17.82 | 17.82 |
| | | | 4/8/2009 | 14.28 | 14.28 |
| | | | 7/15/2009 | 13.4 | 13.4 |
| | | | 10/8/2009 | 15.24 | 15.24 |
| | | | 1/7/2010 | 16.13 | 16.13 |
| | | | 4/7/2010 | 18.97 | 18.97 |
| | | | 7/7/2010 | 19.74 | 19.74 |
| | | | 12/8/2010 | 19.93 | 19.93 |
| | | | 2/3/2011 | 19.86 | 19.86 |
| | | | 4/13/2011 | 20.66 | 20.66 |
| | | | 8/16/2011 | 21.55 | 21.55 |
| | | | 10/26/2011 | 19.6 | 19.6 |
| | | | 1/18/2012 | 22.79 | 22.79 |

Concentrations (mg/L)
Parameter: Chloride
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-52 | 42 | 0 (0%) | 11/15/2001 | 7.14 | 7.14 |
| | | | 1/16/2002 | 7.34 | 7.34 |
| | | | 4/3/2002 | 8.97 | 8.97 |
| | | | 7/2/2002 | 8.54 | 8.54 |
| | | | 10/2/2002 | 8.9 | 8.9 |
| | | | 1/8/2003 | 10.24 | 10.24 |
| | | | 4/2/2003 | 7.83 | 7.83 |
| | | | 7/23/2003 | 8.18 | 8.18 |
| | | | 10/2/2003 | 8.39 | 8.39 |
| | | | 1/7/2004 | 7.84 | 7.84 |
| | | | 4/7/2004 | 7.88 | 7.88 |
| | | | 7/13/2004 | 8.37 | 8.37 |
| | | | 10/6/2004 | 8.68 | 8.68 |
| | | | 1/6/2005 | 9.84 | 9.84 |
| | | | 4/6/2005 | 7.94 | 7.94 |
| | | | 7/27/2005 | 8.07 | 8.07 |
| | | | 10/13/2005 | 8.49 | 8.49 |
| | | | 1/5/2006 | 6.72 | 6.72 |
| | | | 4/6/2006 | 7.08 | 7.08 |
| | | | 7/25/2006 | 8.21 | 8.21 |
| | | | 10/11/2006 | 8.28 | 8.28 |
| | | | 1/4/2007 | 8.07 | 8.07 |
| | | | 4/4/2007 | 8.06 | 8.06 |
| | | | 7/12/2007 | 8.38 | 8.38 |
| | | | 10/10/2007 | 8.66 | 8.66 |
| | | | 1/16/2008 | 8.54 | 8.54 |
| | | | 4/3/2008 | 8.34 | 8.34 |
| | | | 7/23/2008 | 8.61 | 8.61 |
| | | | 10/22/2008 | 8.33 | 8.33 |
| | | | 1/13/2009 | 8.6 | 8.6 |
| | | | 4/8/2009 | 8.58 | 8.58 |
| | | | 7/15/2009 | 8.51 | 8.51 |
| | | | 10/8/2009 | 9.1 | 9.1 |
| | | | 1/7/2010 | 8.91 | 8.91 |
| | | | 4/7/2010 | 8.62 | 8.62 |
| | | | 7/7/2010 | 8.74 | 8.74 |
| | | | 12/8/2010 | 8.74 | 8.74 |
| | | | 2/3/2011 | 8.84 | 8.84 |
| | | | 4/13/2011 | 9.34 | 9.34 |
| | | | 8/16/2011 | 11.01 | 11.01 |
| | | | 10/26/2011 | 28.76 | 28.76 |
| | | | 1/18/2012 | 17.91 | 17.91 |
| B-51 | 32 | 0 (0%) | 11/15/2001 | 22.76 | 22.76 |
| | | | 10/2/2002 | 25.03 | 25.03 |
| | | | 1/8/2003 | 26.61 | 26.61 |
| | | | 4/2/2003 | 25.4 | 25.4 |
| | | | 7/23/2003 | 25.06 | 25.06 |
| | | | 10/2/2003 | 24.72 | 24.72 |
| | | | 1/7/2004 | 22.32 | 22.32 |
| | | | 4/7/2004 | 22.04 | 22.04 |
| | | | 7/13/2004 | 21.34 | 21.34 |
| | | | 10/6/2004 | 22.15 | 22.15 |
| | | | 1/6/2005 | 23.94 | 23.94 |
| | | | 4/6/2005 | 26.82 | 26.82 |
| | | | 7/27/2005 | 27.83 | 27.83 |
| | | | 10/13/2005 | 27.42 | 27.42 |
| | | | 1/5/2006 | 21.37 | 21.37 |
| | | | 4/6/2006 | 27.15 | 27.15 |
| | | | 7/25/2006 | 26.65 | 26.65 |
| | | | 10/11/2006 | 27.32 | 27.32 |
| | | | 1/4/2007 | 26.04 | 26.04 |
| | | | 4/4/2007 | 28.01 | 28.01 |
| | | | 7/12/2007 | 26.3 | 26.3 |
| | | | 10/10/2007 | 26.45 | 26.45 |
| | | | 7/23/2008 | 28.66 | 28.66 |

**Non-Parametric Prediction Interval**
**Inter-Well Comparison**
**Parameter: Ammonia**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
**Maximum Background Value = 6.95**
Confidence Level = 99%
False Positive Rate = 1%

| Location | Date | Count | Mean | Significant |
|---|---|---|---|---|
| B-30A | 4/4/2012 | 1 | 14.28 | TRUE |
| B-32 | 4/4/2012 | 1 | 1.05 | FALSE |
| B-31 | 4/4/2012 | 1 | 0.01 | FALSE |
| DM-1 | 4/4/2012 | 1 | 0.06 | FALSE |
| DM-7 | 4/4/2012 | 1 | 0.02 | FALSE |
| DM-6 | 4/4/2012 | 1 | 0.02 | FALSE |
| DM-5 | 4/4/2012 | 1 | 0.1 | FALSE |

## Shapiro-Francia Test of Normality (Continued)

**Parameter: Ammonia**

Background Locations

Normality Test of Parameter Concentrations

Natural Logarithm Transformation

Non-Detects Replaced with 1/2 LOQ

Total Number of Measurements = 116

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | -3.50656 | 0.163659 | 54.4516 | 189.19 |
| 67 | -3.50656 | 0.184017 | 54.4854 | 188.545 |
| 68 | -3.50656 | 0.207012 | 54.5283 | 187.819 |
| 69 | -3.50656 | 0.227545 | 54.5801 | 187.021 |
| 70 | -3.50656 | 0.250759 | 54.643 | 186.142 |
| 71 | -3.21888 | 0.271509 | 54.7167 | 185.268 |
| 72 | -3.21888 | 0.294992 | 54.8037 | 184.318 |
| 73 | -2.40795 | 0.316004 | 54.9036 | 183.557 |
| 74 | -1.89712 | 0.33981 | 55.019 | 182.913 |
| 75 | -1.83258 | 0.363809 | 55.1514 | 182.246 |
| 76 | 0.548121 | 0.385321 | 55.2999 | 182.457 |
| 77 | 1.30833 | 0.409735 | 55.4677 | 182.993 |
| 78 | 1.39872 | 0.431644 | 55.6541 | 183.597 |
| 79 | 1.40118 | 0.456542 | 55.8625 | 184.237 |
| 80 | 1.47247 | 0.478914 | 56.0918 | 184.942 |
| 81 | 1.48614 | 0.504372 | 56.3462 | 185.692 |
| 82 | 1.51293 | 0.52728 | 56.6243 | 186.489 |
| 83 | 1.51513 | 0.553384 | 56.9305 | 187.328 |
| 84 | 1.53256 | 0.576911 | 57.2633 | 188.212 |
| 85 | 1.53902 | 0.603765 | 57.6278 | 189.141 |
| 86 | 1.54543 | 0.631062 | 58.0261 | 190.116 |
| 87 | 1.55181 | 0.655726 | 58.4561 | 191.134 |
| 88 | 1.55604 | 0.68396 | 58.9239 | 192.198 |
| 89 | 1.55814 | 0.709522 | 59.4273 | 193.304 |
| 90 | 1.57277 | 0.738846 | 59.9732 | 194.466 |
| 91 | 1.57691 | 0.765456 | 60.5591 | 195.673 |
| 92 | 1.57691 | 0.796056 | 61.1928 | 196.928 |
| 93 | 1.58309 | 0.823893 | 61.8716 | 198.232 |
| 94 | 1.60342 | 0.855996 | 62.6043 | 199.605 |
| 95 | 1.60543 | 0.885291 | 63.3881 | 201.026 |
| 96 | 1.60543 | 0.919183 | 64.233 | 202.502 |
| 97 | 1.61144 | 0.954165 | 65.1434 | 204.04 |
| 98 | 1.61939 | 0.986272 | 66.1161 | 205.637 |
| 99 | 1.62137 | 1.02365 | 67.164 | 207.296 |
| 100 | 1.62728 | 1.05812 | 68.2836 | 209.018 |
| 101 | 1.639 | 1.09847 | 69.4903 | 210.819 |
| 102 | 1.639 | 1.1359 | 70.7805 | 212.68 |
| 103 | 1.64287 | 1.18 | 72.1729 | 214.619 |
| 104 | 1.65058 | 1.22123 | 73.6643 | 216.635 |
| 105 | 1.65823 | 1.27024 | 75.2778 | 218.741 |
| 106 | 1.66582 | 1.31652 | 77.011 | 220.934 |
| 107 | 1.69562 | 1.3722 | 78.894 | 223.261 |
| 108 | 1.69745 | 1.4325 | 80.9461 | 225.692 |
| 109 | 1.70656 | 1.49085 | 83.1687 | 228.237 |
| 110 | 1.71199 | 1.56322 | 85.6124 | 230.913 |
| 111 | 1.73166 | 1.63524 | 88.2864 | 233.745 |
| 112 | 1.74047 | 1.72793 | 91.2721 | 236.752 |
| 113 | 1.74746 | 1.82501 | 94.6027 | 239.941 |
| 114 | 1.85942 | 1.95996 | 98.4442 | 243.585 |
| 115 | 1.90211 | 2.12007 | 102.939 | 247.618 |
| 116 | 1.93874 | 2.40892 | 108.742 | 252.288 |

Data Set Standard Deviation = 2.63914

Numerator = 63649.4

Denominator = 87100.5

W Statistic = 0.730758 = 63649.4 / 87100.5

5% Critical value of 0.976 exceeds 0.730758

Evidence of non-normality at 95% level of significance

**Shapiro-Francia Test of Normality**

**Parameter: Ammonia**

**Background Locations**

**Normality Test of Parameter Concentrations**

**Natural Logarithm Transformation**

**Non-Detects Replaced with 1/2 LOQ**

**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | -4.60517 | -2.40892 | 5.80292 | 11.0935 |
| 2 | -4.60517 | -2.12007 | 10.2976 | 20.8568 |
| 3 | -4.60517 | -1.95996 | 14.1391 | 29.8827 |
| 4 | -4.60517 | -1.82501 | 17.4697 | 38.2872 |
| 5 | -4.60517 | -1.72793 | 20.4554 | 46.2446 |
| 6 | -4.60517 | -1.63524 | 23.1294 | 53.7751 |
| 7 | -4.60517 | -1.56322 | 25.5731 | 60.974 |
| 8 | -4.60517 | -1.49085 | 27.7957 | 67.8397 |
| 9 | -4.60517 | -1.4325 | 29.8478 | 74.4366 |
| 10 | -4.60517 | -1.3722 | 31.7308 | 80.7558 |
| 11 | -4.60517 | -1.31652 | 33.464 | 86.8186 |
| 12 | -4.60517 | -1.27024 | 35.0775 | 92.6683 |
| 13 | -4.60517 | -1.22123 | 36.5689 | 98.2923 |
| 14 | -3.91202 | -1.18 | 37.9613 | 102.908 |
| 15 | -3.91202 | -1.1359 | 39.2515 | 107.352 |
| 16 | -3.91202 | -1.09847 | 40.4582 | 111.649 |
| 17 | -3.91202 | -1.05812 | 41.5778 | 115.789 |
| 18 | -3.91202 | -1.02365 | 42.6257 | 119.793 |
| 19 | -3.91202 | -0.986272 | 43.5984 | 123.652 |
| 20 | -3.91202 | -0.954165 | 44.5088 | 127.384 |
| 21 | -3.91202 | -0.919183 | 45.3537 | 130.98 |
| 22 | -3.91202 | -0.885291 | 46.1375 | 134.443 |
| 23 | -3.91202 | -0.855996 | 46.8702 | 137.792 |
| 24 | -3.91202 | -0.823893 | 47.549 | 141.015 |
| 25 | -3.91202 | -0.796056 | 48.1827 | 144.129 |
| 26 | -3.91202 | -0.765456 | 48.7686 | 147.124 |
| 27 | -3.91202 | -0.738846 | 49.3145 | 150.014 |
| 28 | -3.91202 | -0.709522 | 49.8179 | 152.79 |
| 29 | -3.91202 | -0.68396 | 50.2857 | 155.466 |
| 30 | -3.91202 | -0.655726 | 50.7157 | 158.031 |
| 31 | -3.91202 | -0.631062 | 51.114 | 160.5 |
| 32 | -3.91202 | -0.603765 | 51.4785 | 162.862 |
| 33 | -3.91202 | -0.576911 | 51.8113 | 165.118 |
| 34 | -3.91202 | -0.553384 | 52.1175 | 167.283 |
| 35 | -3.91202 | -0.52728 | 52.3956 | 169.346 |
| 36 | -3.91202 | -0.504372 | 52.65 | 171.319 |
| 37 | -3.91202 | -0.478914 | 52.8793 | 173.193 |
| 38 | -3.91202 | -0.456542 | 53.0877 | 174.979 |
| 39 | -3.91202 | -0.431644 | 53.2741 | 176.667 |
| 40 | -3.91202 | -0.409735 | 53.4419 | 178.27 |
| 41 | -3.91202 | -0.385321 | 53.5904 | 179.777 |
| 42 | -3.91202 | -0.363809 | 53.7228 | 181.201 |
| 43 | -3.91202 | -0.33981 | 53.8382 | 182.53 |
| 44 | -3.91202 | -0.316004 | 53.9381 | 183.766 |
| 45 | -3.68888 | -0.294992 | 54.0251 | 184.854 |
| 46 | -3.68888 | -0.271509 | 54.0988 | 185.856 |
| 47 | -3.68888 | -0.250759 | 54.1617 | 186.781 |
| 48 | -3.68888 | -0.227545 | 54.2135 | 187.62 |
| 49 | -3.68888 | -0.207012 | 54.2564 | 188.384 |
| 50 | -3.68888 | -0.184017 | 54.2902 | 189.063 |
| 51 | -3.68888 | -0.163659 | 54.317 | 189.667 |
| 52 | -3.68888 | -0.140835 | 54.3368 | 190.186 |
| 53 | -3.68888 | -0.12061 | 54.3514 | 190.631 |
| 54 | -3.68888 | -0.0979139 | 54.361 | 190.992 |
| 55 | -3.68888 | -0.0752698 | 54.3666 | 191.27 |
| 56 | -3.68888 | -0.0551734 | 54.3697 | 191.473 |
| 57 | -3.68888 | -0.0325917 | 54.3707 | 191.594 |
| 58 | -3.68888 | -0.0125328 | 54.3709 | 191.64 |
| 59 | -3.50656 | 0.0125328 | 54.3711 | 191.596 |
| 60 | -3.50656 | 0.0325917 | 54.3721 | 191.482 |
| 61 | -3.50656 | 0.0551734 | 54.3752 | 191.288 |
| 62 | -3.50656 | 0.0752698 | 54.3808 | 191.024 |
| 63 | -3.50656 | 0.0979139 | 54.3904 | 190.681 |
| 64 | -3.50656 | 0.12061 | 54.405 | 190.258 |
| 65 | -3.50656 | 0.140835 | 54.4248 | 189.764 |

## Shapiro-Francia Test of Normality (Continued)

**Parameter: Ammonia**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with 1/2 LOQ**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 0.03 | 0.163659 | 54.4516 | -0.682823 |
| 67 | 0.03 | 0.184017 | 54.4854 | -0.677303 |
| 68 | 0.03 | 0.207012 | 54.5283 | -0.671092 |
| 69 | 0.03 | 0.227545 | 54.5801 | -0.664266 |
| 70 | 0.03 | 0.250759 | 54.643 | -0.656743 |
| 71 | 0.04 | 0.271509 | 54.7167 | -0.645883 |
| 72 | 0.04 | 0.294992 | 54.8037 | -0.634083 |
| 73 | 0.09 | 0.316004 | 54.9036 | -0.605643 |
| 74 | 0.15 | 0.33981 | 55.019 | -0.554671 |
| 75 | 0.16 | 0.363809 | 55.1514 | -0.496462 |
| 76 | 1.73 | 0.385321 | 55.2999 | 0.170144 |
| 77 | 3.7 | 0.409735 | 55.4677 | 1.68616 |
| 78 | 4.05 | 0.431644 | 55.6541 | 3.43432 |
| 79 | 4.06 | 0.456542 | 55.8625 | 5.28788 |
| 80 | 4.36 | 0.478914 | 56.0918 | 7.37595 |
| 81 | 4.42 | 0.504372 | 56.3462 | 9.60527 |
| 82 | 4.54 | 0.52728 | 56.6243 | 11.9991 |
| 83 | 4.55 | 0.553384 | 56.9305 | 14.517 |
| 84 | 4.63 | 0.576911 | 57.2633 | 17.1881 |
| 85 | 4.66 | 0.603765 | 57.6278 | 20.0017 |
| 86 | 4.69 | 0.631062 | 58.0261 | 22.9613 |
| 87 | 4.72 | 0.655726 | 58.4561 | 26.0564 |
| 88 | 4.74 | 0.68396 | 58.9239 | 29.2983 |
| 89 | 4.75 | 0.709522 | 59.4273 | 32.6686 |
| 90 | 4.82 | 0.738846 | 59.9732 | 36.2298 |
| 91 | 4.84 | 0.765456 | 60.5591 | 39.9346 |
| 92 | 4.84 | 0.796056 | 61.1928 | 43.7875 |
| 93 | 4.87 | 0.823893 | 61.8716 | 47.7999 |
| 94 | 4.97 | 0.855996 | 62.6043 | 52.0542 |
| 95 | 4.98 | 0.885291 | 63.3881 | 56.4629 |
| 96 | 4.98 | 0.919183 | 64.233 | 61.0405 |
| 97 | 5.01 | 0.954165 | 65.1434 | 65.8208 |
| 98 | 5.05 | 0.986272 | 66.1161 | 70.8015 |
| 99 | 5.06 | 1.02365 | 67.164 | 75.9812 |
| 100 | 5.09 | 1.05812 | 68.2836 | 81.367 |
| 101 | 5.15 | 1.09847 | 69.4903 | 87.0241 |
| 102 | 5.15 | 1.1359 | 70.7805 | 92.874 |
| 103 | 5.17 | 1.18 | 72.1729 | 98.9746 |
| 104 | 5.21 | 1.22123 | 73.6643 | 105.337 |
| 105 | 5.25 | 1.27024 | 75.2778 | 112.006 |
| 106 | 5.29 | 1.31652 | 77.011 | 118.97 |
| 107 | 5.45 | 1.3722 | 78.894 | 126.449 |
| 108 | 5.46 | 1.4325 | 80.9461 | 134.27 |
| 109 | 5.51 | 1.49085 | 83.1687 | 142.485 |
| 110 | 5.54 | 1.56322 | 85.6124 | 151.145 |
| 111 | 5.65 | 1.63524 | 88.2864 | 160.384 |
| 112 | 5.7 | 1.72793 | 91.2721 | 170.233 |
| 113 | 5.74 | 1.82501 | 94.6027 | 180.709 |
| 114 | 6.42 | 1.95996 | 98.4442 | 193.292 |
| 115 | 6.7 | 2.12007 | 102.939 | 207.496 |
| 116 | 6.95 | 2.40892 | 108.742 | 224.238 |

Data Set Standard Deviation = 2.43128
Numerator = 50282.9
Denominator = 73920.6
W Statistic = 0.680228 = 50282.9 / 73920.6

5% Critical value of 0.976 exceeds 0.680228
Evidence of non-normality at 95% level of significance

## Shapiro-Francia Test of Normality

**Parameter: Ammonia**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with 1/2 LOQ**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 0.01 | -2.40892 | 5.80292 | -0.0240892 |
| 2 | 0.01 | -2.12007 | 10.2976 | -0.0452899 |
| 3 | 0.01 | -1.95996 | 14.1391 | -0.0648895 |
| 4 | 0.01 | -1.82501 | 17.4697 | -0.0831396 |
| 5 | 0.01 | -1.72793 | 20.4554 | -0.100419 |
| 6 | 0.01 | -1.63524 | 23.1294 | -0.116771 |
| 7 | 0.01 | -1.56322 | 25.5731 | -0.132403 |
| 8 | 0.01 | -1.49085 | 27.7957 | -0.147312 |
| 9 | 0.01 | -1.4325 | 29.8478 | -0.161637 |
| 10 | 0.01 | -1.3722 | 31.7308 | -0.175359 |
| 11 | 0.01 | -1.31652 | 33.464 | -0.188524 |
| 12 | 0.01 | -1.27024 | 35.0775 | -0.201227 |
| 13 | 0.01 | -1.22123 | 36.5689 | -0.213439 |
| 14 | 0.02 | -1.18 | 37.9613 | -0.237039 |
| 15 | 0.02 | -1.1359 | 39.2515 | -0.259757 |
| 16 | 0.02 | -1.09847 | 40.4582 | -0.281726 |
| 17 | 0.02 | -1.05812 | 41.5778 | -0.302889 |
| 18 | 0.02 | -1.02365 | 42.6257 | -0.323362 |
| 19 | 0.02 | -0.986272 | 43.5984 | -0.343087 |
| 20 | 0.02 | -0.954165 | 44.5088 | -0.36217 |
| 21 | 0.02 | -0.919183 | 45.3537 | -0.380554 |
| 22 | 0.02 | -0.885291 | 46.1375 | -0.39826 |
| 23 | 0.02 | -0.855996 | 46.8702 | -0.41538 |
| 24 | 0.02 | -0.823893 | 47.549 | -0.431858 |
| 25 | 0.02 | -0.796056 | 48.1827 | -0.447779 |
| 26 | 0.02 | -0.765456 | 48.7686 | -0.463088 |
| 27 | 0.02 | -0.738846 | 49.3145 | -0.477865 |
| 28 | 0.02 | -0.709522 | 49.8179 | -0.492055 |
| 29 | 0.02 | -0.68396 | 50.2857 | -0.505735 |
| 30 | 0.02 | -0.655726 | 50.7157 | -0.518849 |
| 31 | 0.02 | -0.631062 | 51.114 | -0.53147 |
| 32 | 0.02 | -0.603765 | 51.4785 | -0.543546 |
| 33 | 0.02 | -0.576911 | 51.8113 | -0.555084 |
| 34 | 0.02 | -0.553384 | 52.1175 | -0.566151 |
| 35 | 0.02 | -0.52728 | 52.3956 | -0.576697 |
| 36 | 0.02 | -0.504372 | 52.65 | -0.586785 |
| 37 | 0.02 | -0.478914 | 52.8793 | -0.596363 |
| 38 | 0.02 | -0.456542 | 53.0877 | -0.605494 |
| 39 | 0.02 | -0.431644 | 53.2741 | -0.614127 |
| 40 | 0.02 | -0.409735 | 53.4419 | -0.622321 |
| 41 | 0.02 | -0.385321 | 53.5904 | -0.630028 |
| 42 | 0.02 | -0.363809 | 53.7228 | -0.637304 |
| 43 | 0.02 | -0.33981 | 53.8382 | -0.6441 |
| 44 | 0.02 | -0.316004 | 53.9381 | -0.65042 |
| 45 | 0.025 | -0.294992 | 54.0251 | -0.657795 |
| 46 | 0.025 | -0.271509 | 54.0988 | -0.664583 |
| 47 | 0.025 | -0.250759 | 54.1617 | -0.670852 |
| 48 | 0.025 | -0.227545 | 54.2135 | -0.67654 |
| 49 | 0.025 | -0.207012 | 54.2564 | -0.681716 |
| 50 | 0.025 | -0.184017 | 54.2902 | -0.686316 |
| 51 | 0.025 | -0.163659 | 54.317 | -0.690407 |
| 52 | 0.025 | -0.140835 | 54.3368 | -0.693928 |
| 53 | 0.025 | -0.12061 | 54.3514 | -0.696944 |
| 54 | 0.025 | -0.0979139 | 54.361 | -0.699391 |
| 55 | 0.025 | -0.0752698 | 54.3666 | -0.701273 |
| 56 | 0.025 | -0.0551734 | 54.3697 | -0.702653 |
| 57 | 0.025 | -0.0325917 | 54.3707 | -0.703467 |
| 58 | 0.025 | -0.0125328 | 54.3709 | -0.703781 |
| 59 | 0.03 | 0.0125328 | 54.3711 | -0.703405 |
| 60 | 0.03 | 0.0325917 | 54.3721 | -0.702427 |
| 61 | 0.03 | 0.0551734 | 54.3752 | -0.700772 |
| 62 | 0.03 | 0.0752698 | 54.3808 | -0.698514 |
| 63 | 0.03 | 0.0979139 | 54.3904 | -0.695576 |
| 64 | 0.03 | 0.12061 | 54.405 | -0.691958 |
| 65 | 0.03 | 0.140835 | 54.4248 | -0.687733 |

**Rosner's Test for Outliers (Continued)**
**Parameter: Ammonia**
**Background Locations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

--------------------------------------------
Iteration i = 3
Mean of 113 measurements = 1.65195
Std Dev = 2.32272
x(i+1) = 5.74 from measurement 11/15/2001 from location B-50
Rosner Statistic R = |5.74 - 1.65195|/2.32272 = 1.76003
Lambda(116, 4, 0.05) = 3.4148
1.76003 < 3.4148 -- No outliers detected for i = 3

--------------------------------------------
Iteration i = 2
Mean of 114 measurements = 1.69377
Std Dev = 2.35515
x(i+1) = 6.42 from measurement 7/23/2003 from location B-50
Rosner Statistic R = |6.42 - 1.69377|/2.35515 = 2.00677
Lambda(116, 3, 0.05) = 3.4216
2.00677 < 3.4216 -- No outliers detected for i = 2

--------------------------------------------
Iteration i = 1
Mean of 115 measurements = 1.7373
Std Dev = 2.39081
x(i+1) = 6.7 from measurement 1/13/2009 from location B-50
Rosner Statistic R = |6.7 - 1.7373|/2.39081 = 2.07574
Lambda(116, 2, 0.05) = 3.4216
2.07574 < 3.4216 -- No outliers detected for i = 1

--------------------------------------------
Iteration i = 0
Mean of 116 measurements = 1.78224
Std Dev = 2.4291
x(i+1) = 6.95 from measurement 1/8/2003 from location B-50
Rosner Statistic R = |6.95 - 1.78224|/2.4291 = 2.12744
Lambda(116, 1, 0.05) = 3.4248
2.12744 < 3.4248 -- No outliers detected for i = 0

**NO OUTLIERS DETECTED**

**Rosner's Test for Outliers**
**Parameter: Ammonia**
**Background Locations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

Data set mean = 1.78224

10 most extreme of 116 measurements
by order of magnitude difference from the mean

| | | | | |
|---|---|---|---|---|
| 1 | 1/8/2003 | B-50 | 6.95 | 5.16776 |
| 2 | 1/13/2009 | B-50 | 6.7 | 4.91776 |
| 3 | 7/23/2003 | B-50 | 6.42 | 4.63776 |
| 4 | 11/15/2001 | B-50 | 5.74 | 3.95776 |
| 5 | 4/8/2009 | B-50 | 5.7 | 3.91776 |
| 6 | 4/6/2005 | B-50 | 5.65 | 3.86776 |
| 7 | 1/16/2002 | B-50 | 5.54 | 3.75776 |
| 8 | 4/2/2003 | B-50 | 5.51 | 3.72776 |
| 9 | 4/3/2002 | B-50 | 5.46 | 3.67776 |
| 10 | 7/13/2004 | B-50 | 5.45 | 3.66776 |

------------------------------------------
Iteration i = 9
Mean of 107 measurements = 1.43056
Std Dev = 2.18359
x(i+1) = 5.45 from measurement 7/13/2004 from location B-50
Rosner Statistic R = |5.45 - 1.43056|/2.18359 = 1.84075
Lambda(116, 10, 0.05) = 3.398
1.84075 < 3.398 -- No outliers detected for i = 9

------------------------------------------
Iteration i = 8
Mean of 108 measurements = 1.46787
Std Dev = 2.20767
x(i+1) = 5.46 from measurement 4/3/2002 from location B-50
Rosner Statistic R = |5.46 - 1.46787|/2.20767 = 1.8083
Lambda(116, 9, 0.05) = 3.40136
1.8083 < 3.40136 -- No outliers detected for i = 8

------------------------------------------
Iteration i = 7
Mean of 109 measurements = 1.50495
Std Dev = 2.23128
x(i+1) = 5.51 from measurement 4/2/2003 from location B-50
Rosner Statistic R = |5.51 - 1.50495|/2.23128 = 1.79496
Lambda(116, 8, 0.05) = 3.40472
1.79496 < 3.40472 -- No outliers detected for i = 7

------------------------------------------
Iteration i = 6
Mean of 110 measurements = 1.54164
Std Dev = 2.25409
x(i+1) = 5.54 from measurement 1/16/2002 from location B-50
Rosner Statistic R = |5.54 - 1.54164|/2.25409 = 1.77382
Lambda(116, 7, 0.05) = 3.40808
1.77382 < 3.40808 -- No outliers detected for i = 6

------------------------------------------
Iteration i = 5
Mean of 111 measurements = 1.57865
Std Dev = 2.27745
x(i+1) = 5.65 from measurement 4/6/2005 from location B-50
Rosner Statistic R = |5.65 - 1.57865|/2.27745 = 1.78768
Lambda(116, 6, 0.05) = 3.41144
1.78768 < 3.41144 -- No outliers detected for i = 5

------------------------------------------
Iteration i = 4
Mean of 112 measurements = 1.61545
Std Dev = 2.30038
x(i+1) = 5.7 from measurement 4/8/2009 from location B-50
Rosner Statistic R = |5.7 - 1.61545|/2.30038 = 1.7756
Lambda(116, 5, 0.05) = 3.4148
1.7756 < 3.4148 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Ammonia
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 12.0690%
Total Background Measurements: 116
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| | | | 7/23/2008 | 0.03 J,B | 0.03 J,B |
| | | | 10/22/2008 | 0.02 J, B | 0.02 J, B |
| | | | 1/13/2009 | 0.01 J | 0.01 J |
| | | | 4/8/2009 | 0.01 J,B | 0.01 J,B |
| | | | 7/15/2009 | 0.03 J,B | 0.03 J,B |
| | | | 1/7/2010 | 0.02 J,B | 0.02 J,B |
| | | | 4/7/2010 | 0.02 J,B | 0.02 J,B |
| | | | 7/7/2010 | 0.02 J | 0.02 J |
| | | | 8/16/2011 | 0.02 J | 0.02 J |
| | | | 10/26/2011 | 0.02 J | 0.02 J |
| B-50 | 42 | 0 (0%) | 11/15/2001 | 5.74 | 5.74 |
| | | | 1/16/2002 | 5.54 | 5.54 |
| | | | 4/3/2002 | 5.46 | 5.46 |
| | | | 7/2/2002 | 0.15 | 0.15 |
| | | | 10/2/2002 | 5.17 | 5.17 |
| | | | 1/8/2003 | 6.95 | 6.95 |
| | | | 4/2/2003 | 5.51 | 5.51 |
| | | | 7/23/2003 | 6.42 | 6.42 |
| | | | 10/2/2003 | 5.21 | 5.21 |
| | | | 1/7/2004 | 4.87 | 4.87 |
| | | | 4/7/2004 | 5.29 | 5.29 |
| | | | 7/13/2004 | 5.45 | 5.45 |
| | | | 10/6/2004 | 4.97 | 4.97 |
| | | | 1/6/2005 | 5.15 | 5.15 |
| | | | 4/6/2005 | 5.65 | 5.65 |
| | | | 7/27/2005 | 4.98 | 4.98 |
| | | | 10/13/2005 | 4.55 | 4.55 |
| | | | 1/5/2006 | 4.82 | 4.82 |
| | | | 4/6/2006 | 4.98 | 4.98 |
| | | | 7/25/2006 | 5.25 | 5.25 |
| | | | 10/11/2006 | 5.15 | 5.15 |
| | | | 1/4/2007 | 4.84 | 4.84 |
| | | | 4/4/2007 | 3.7 | 3.7 |
| | | | 7/12/2007 | 4.74 | 4.74 |
| | | | 10/10/2007 | 5.06 | 5.06 |
| | | | 1/16/2008 | 4.42 | 4.42 |
| | | | 4/3/2008 | 5.01 | 5.01 |
| | | | 7/23/2008 | 5.05 | 5.05 |
| | | | 10/22/2008 | 4.72 | 4.72 |
| | | | 1/13/2009 | 6.7 | 6.7 |
| | | | 4/8/2009 | 5.7 | 5.7 |
| | | | 7/15/2009 | 4.63 | 4.63 |
| | | | 10/8/2009 | 4.66 | 4.66 |
| | | | 1/7/2010 | 4.69 | 4.69 |
| | | | 4/7/2010 | 4.05 | 4.05 |
| | | | 7/7/2010 | 4.06 | 4.06 |
| | | | 12/8/2010 | 5.09 | 5.09 |
| | | | 2/3/2011 | 4.84 | 4.84 |
| | | | 4/13/2011 | 4.36 | 4.36 |
| | | | 8/16/2011 | 1.73 | 1.73 |
| | | | 10/26/2011 | 4.54 | 4.54 |
| | | | 1/18/2012 | 4.75 | 4.75 |

Concentrations (mg/L)
Parameter: Ammonia
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 12.0690%
Total Background Measurements: 116
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-52 | 42 | 12 (28.5714%) | 11/15/2001 | 0.09 | 0.09 |
| | | | 1/16/2002 | 0.03 J | 0.03 J |
| | | | 4/3/2002 | 0.02 J | 0.02 J |
| | | | 7/2/2002 | 0.02 J | 0.02 J |
| | | | 10/2/2002 | 0.01 J | 0.01 J |
| | | | 1/8/2003 | 0.01 J | 0.01 J |
| | | | 4/2/2003 | 0.02 J | 0.02 J |
| | | | 7/23/2003 | ND<0.05 | ND<0.05 |
| | | | 10/2/2003 | ND<0.05 | ND<0.05 |
| | | | 1/7/2004 | ND<0.05 | ND<0.05 |
| | | | 4/7/2004 | 0.02 J | 0.02 J |
| | | | 7/13/2004 | 0.02 JB | 0.02 JB |
| | | | 10/6/2004 | 0.01 JB | 0.01 JB |
| | | | 1/6/2005 | 0.02 JB | 0.02 JB |
| | | | 4/6/2005 | ND<0.05 | ND<0.05 |
| | | | 7/27/2005 | 0.02 J | 0.02 J |
| | | | 10/13/2005 | 0.02 JB | 0.02 JB |
| | | | 1/5/2006 | 0.02 JB | 0.02 JB |
| | | | 4/6/2006 | 0.02 JB | 0.02 JB |
| | | | 7/25/2006 | 0.02 J | 0.02 J |
| | | | 10/11/2006 | ND<0.05 | ND<0.05 |
| | | | 1/4/2007 | ND<0.05 | ND<0.05 |
| | | | 4/4/2007 | ND<0.05 | ND<0.05 |
| | | | 7/12/2007 | ND<0.05 | ND<0.05 |
| | | | 10/10/2007 | ND<0.05 | ND<0.05 |
| | | | 1/16/2008 | 0.01 J | 0.01 J |
| | | | 4/3/2008 | 0.02 J | 0.02 J |
| | | | 7/23/2008 | 0.02 J,B | 0.02 J,B |
| | | | 10/22/2008 | ND<0.05 | ND<0.05 |
| | | | 1/13/2009 | ND<0.05 | ND<0.05 |
| | | | 4/8/2009 | ND<0.05 | ND<0.05 |
| | | | 7/15/2009 | 0.02 J,B | 0.02 J,B |
| | | | 10/8/2009 | 0.02 J,B | 0.02 J,B |
| | | | 1/7/2010 | 0.02 J,B | 0.02 J,B |
| | | | 4/7/2010 | 0.01 J,B | 0.01 J,B |
| | | | 7/7/2010 | 0.02 J | 0.02 J |
| | | | 12/8/2010 | 0.02 J | 0.02 J |
| | | | 2/3/2011 | 0.04 J,B | 0.04 J,B |
| | | | 4/13/2011 | 0.02 J | 0.02 J |
| | | | 8/16/2011 | 0.02 J | 0.02 J |
| | | | 10/26/2011 | 0.01 J | 0.01 J |
| | | | 1/18/2012 | 0.01 J,B | 0.01 J,B |
| B-51 | 32 | 2 (6.25%) | 11/15/2001 | 0.16 | 0.16 |
| | | | 10/2/2002 | 0.02 J | 0.02 J |
| | | | 1/8/2003 | 0.02 J | 0.02 J |
| | | | 4/2/2003 | 0.03 J | 0.03 J |
| | | | 7/23/2003 | ND<0.05 | ND<0.05 |
| | | | 10/2/2003 | ND<0.05 | ND<0.05 |
| | | | 1/7/2004 | 0.03 J | 0.03 J |
| | | | 4/7/2004 | 0.02 J | 0.02 J |
| | | | 7/13/2004 | 0.03 JB | 0.03 JB |
| | | | 10/6/2004 | 0.03 JB | 0.03 JB |
| | | | 1/6/2005 | 0.03 JB | 0.03 JB |
| | | | 4/6/2005 | 0.02 J | 0.02 J |
| | | | 7/27/2005 | 0.04 J | 0.04 J |
| | | | 10/13/2005 | 0.03 JB | 0.03 JB |
| | | | 1/5/2006 | 0.03 JB | 0.03 JB |
| | | | 4/6/2006 | 0.03 JB | 0.03 JB |
| | | | 7/25/2006 | 0.03 J | 0.03 J |
| | | | 10/11/2006 | 0.01 J,B | 0.01 J,B |
| | | | 1/4/2007 | 0.02 J | 0.02 J |
| | | | 4/4/2007 | 0.01 J | 0.01 J |
| | | | 7/12/2007 | 0.01 J | 0.01 J |
| | | | 10/10/2007 | 0.01 J | 0.01 J |

**Non-Parametric Prediction Interval**
**Inter-Well Comparison**
**Parameter: Zinc, Dissolved**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
**Maximum Background Value = 0.041**
Confidence Level = 99%
False Positive Rate = 1%

| Location | Date | Count | Mean | Significant |
|---|---|---|---|---|
| B-30A | 4/4/2012 | 1 | 0.018 | FALSE |
| B-32 | 4/4/2012 | 1 | 0.02 | FALSE |
| DM-7 | 4/4/2012 | 1 | 0.019 | FALSE |
| DM-6 | 4/4/2012 | 1 | 0.017 | FALSE |
| B-31 | 4/4/2012 | 1 | 0.017 | FALSE |
| DM-5 | 4/4/2012 | 1 | 0.019 | FALSE |
| DM-1 | 4/4/2012 | 1 | 0.035 | FALSE |

Shapiro-Francia Test of Normality (Continued)
Parameter: Zinc, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Non-Detects Replaced with Quantitation Limit
Total Number of Measurements = 116

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | -3.50656 | 0.163659 | 54.4516 | 193.087 |
| 67 | -3.50656 | 0.184017 | 54.4854 | 192.442 |
| 68 | -3.50656 | 0.207012 | 54.5283 | 191.716 |
| 69 | -3.50656 | 0.227545 | 54.5801 | 190.918 |
| 70 | -3.50656 | 0.250759 | 54.643 | 190.038 |
| 71 | -3.50656 | 0.271509 | 54.7167 | 189.086 |
| 72 | -3.50656 | 0.294992 | 54.8037 | 188.052 |
| 73 | -3.50656 | 0.316004 | 54.9036 | 186.944 |
| 74 | -3.50656 | 0.33981 | 55.019 | 185.752 |
| 75 | -3.50656 | 0.363809 | 55.1514 | 184.477 |
| 76 | -3.50656 | 0.385321 | 55.2999 | 183.125 |
| 77 | -3.50656 | 0.409735 | 55.4677 | 181.689 |
| 78 | -3.50656 | 0.431644 | 55.6541 | 180.175 |
| 79 | -3.50656 | 0.456542 | 55.8625 | 178.574 |
| 80 | -3.50656 | 0.478914 | 56.0918 | 176.895 |
| 81 | -3.50656 | 0.504372 | 56.3462 | 175.126 |
| 82 | -3.50656 | 0.52728 | 56.6243 | 173.277 |
| 83 | -3.50656 | 0.553384 | 56.9305 | 171.337 |
| 84 | -3.50656 | 0.576911 | 57.2633 | 169.314 |
| 85 | -3.50656 | 0.603765 | 57.6278 | 167.197 |
| 86 | -3.50656 | 0.631062 | 58.0261 | 164.984 |
| 87 | -3.50656 | 0.655726 | 58.4561 | 162.685 |
| 88 | -3.50656 | 0.68396 | 58.9239 | 160.286 |
| 89 | -3.50656 | 0.709522 | 59.4273 | 157.798 |
| 90 | -3.50656 | 0.738846 | 59.9732 | 155.207 |
| 91 | -3.50656 | 0.765456 | 60.5591 | 152.523 |
| 92 | -3.50656 | 0.796056 | 61.1928 | 149.732 |
| 93 | -3.50656 | 0.823893 | 61.8716 | 146.843 |
| 94 | -3.50656 | 0.855996 | 62.6043 | 143.841 |
| 95 | -3.50656 | 0.885291 | 63.3881 | 140.737 |
| 96 | -3.50656 | 0.919183 | 64.233 | 137.514 |
| 97 | -3.50656 | 0.954165 | 65.1434 | 134.168 |
| 98 | -3.50656 | 0.986272 | 66.1161 | 130.71 |
| 99 | -3.50656 | 1.02365 | 67.164 | 127.12 |
| 100 | -3.50656 | 1.05812 | 68.2836 | 123.41 |
| 101 | -3.50656 | 1.09847 | 69.4903 | 119.558 |
| 102 | -3.50656 | 1.1359 | 70.7805 | 115.575 |
| 103 | -3.50656 | 1.18 | 72.1729 | 111.437 |
| 104 | -3.50656 | 1.22123 | 73.6643 | 107.155 |
| 105 | -3.50656 | 1.27024 | 75.2778 | 102.701 |
| 106 | -3.50656 | 1.31652 | 77.011 | 98.0841 |
| 107 | -3.50656 | 1.3722 | 78.894 | 93.2724 |
| 108 | -3.50656 | 1.4325 | 80.9461 | 88.2492 |
| 109 | -3.50656 | 1.49085 | 83.1687 | 83.0214 |
| 110 | -3.50656 | 1.56322 | 85.6124 | 77.5399 |
| 111 | -3.50656 | 1.63524 | 88.2864 | 71.8059 |
| 112 | -3.47377 | 1.72793 | 91.2721 | 65.8034 |
| 113 | -3.44202 | 1.82501 | 94.6027 | 59.5217 |
| 114 | -3.41125 | 1.95996 | 98.4442 | 52.8358 |
| 115 | -3.29684 | 2.12007 | 102.939 | 45.8463 |
| 116 | -3.19418 | 2.40892 | 108.742 | 38.1517 |

Data Set Standard Deviation = 0.377096
Numerator = 1455.56
Denominator = 1778.27
W Statistic = 0.818523 = 1455.56 / 1778.27

5% Critical value of 0.976 exceeds 0.818523
Evidence of non-normality at 95% level of significance

## Shapiro-Francia Test of Normality

**Parameter: Zinc, Dissolved**

Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Non-Detects Replaced with Quantitation Limit
Total Number of Measurements = 116

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | -4.60517 | -2.40892 | 5.80292 | 11.0935 |
| 2 | -4.60517 | -2.12007 | 10.2976 | 20.8568 |
| 3 | -4.60517 | -1.95996 | 14.1391 | 29.8827 |
| 4 | -4.50986 | -1.82501 | 17.4697 | 38.1133 |
| 5 | -4.50986 | -1.72793 | 20.4554 | 45.906 |
| 6 | -4.50986 | -1.63524 | 23.1294 | 53.2807 |
| 7 | -4.50986 | -1.56322 | 25.5731 | 60.3306 |
| 8 | -4.42285 | -1.49085 | 27.7957 | 66.9244 |
| 9 | -4.42285 | -1.4325 | 29.8478 | 73.2601 |
| 10 | -4.42285 | -1.3722 | 31.7308 | 79.3292 |
| 11 | -4.42285 | -1.31652 | 33.464 | 85.152 |
| 12 | -4.42285 | -1.27024 | 35.0775 | 90.77 |
| 13 | -4.34281 | -1.22123 | 36.5689 | 96.0736 |
| 14 | -4.34281 | 1.18 | 37.9613 | 101.198 |
| 15 | -4.34281 | -1.1359 | 39.2515 | 106.131 |
| 16 | -4.34281 | -1.09847 | 40.4582 | 110.902 |
| 17 | -4.34281 | -1.05812 | 41.5778 | 115.497 |
| 18 | -4.2687 | -1.02365 | 42.6257 | 119.866 |
| 19 | -4.2687 | -0.986272 | 43.5984 | 124.076 |
| 20 | -4.2687 | -0.954165 | 44.5088 | 128.15 |
| 21 | -4.2687 | -0.919183 | 45.3537 | 132.073 |
| 22 | -4.2687 | -0.885291 | 46.1375 | 135.852 |
| 23 | -4.2687 | -0.855996 | 46.8702 | 139.506 |
| 24 | -4.2687 | -0.823893 | 47.549 | 143.023 |
| 25 | -4.19971 | -0.796056 | 48.1827 | 146.366 |
| 26 | -4.19971 | -0.765456 | 48.7686 | 149.581 |
| 27 | -4.19971 | -0.738846 | 49.3145 | 152.684 |
| 28 | -4.19971 | -0.709522 | 49.8179 | 155.664 |
| 29 | -4.13517 | -0.68396 | 50.2857 | 158.492 |
| 30 | -4.13517 | -0.655726 | 50.7157 | 161.204 |
| 31 | -4.13517 | -0.631062 | 51.114 | 163.813 |
| 32 | -4.07454 | -0.603765 | 51.4785 | 166.273 |
| 33 | -4.07454 | -0.576911 | 51.8113 | 168.624 |
| 34 | -4.01738 | -0.553384 | 52.1175 | 170.847 |
| 35 | -4.01738 | -0.52728 | 52.3956 | 172.965 |
| 36 | -4.01738 | -0.504372 | 52.65 | 174.992 |
| 37 | -3.96332 | -0.478914 | 52.8793 | 176.89 |
| 38 | -3.96332 | -0.456542 | 53.0877 | 178.699 |
| 39 | -3.96332 | -0.431644 | 53.2741 | 180.41 |
| 40 | -3.96332 | -0.409735 | 53.4419 | 182.034 |
| 41 | -3.96332 | -0.385321 | 53.5904 | 183.561 |
| 42 | -3.91202 | -0.363809 | 53.7228 | 184.984 |
| 43 | -3.91202 | -0.33981 | 53.8382 | 186.313 |
| 44 | -3.86323 | -0.316004 | 53.9381 | 187.534 |
| 45 | -3.86323 | -0.294992 | 54.0251 | 188.674 |
| 46 | -3.86323 | -0.271509 | 54.0988 | 189.723 |
| 47 | -3.81671 | -0.250759 | 54.1617 | 190.68 |
| 48 | -3.77226 | -0.227545 | 54.2135 | 191.538 |
| 49 | -3.77226 | -0.207012 | 54.2564 | 192.319 |
| 50 | -3.77226 | -0.184017 | 54.2902 | 193.013 |
| 51 | -3.7297 | -0.163659 | 54.317 | 193.624 |
| 52 | -3.61192 | -0.140835 | 54.3368 | 194.132 |
| 53 | -3.57555 | -0.12061 | 54.3514 | 194.564 |
| 54 | -3.57555 | -0.0979139 | 54.361 | 194.914 |
| 55 | -3.57555 | -0.0752698 | 54.3666 | 195.183 |
| 56 | -3.54046 | -0.0551734 | 54.3697 | 195.378 |
| 57 | -3.50656 | -0.0325917 | 54.3707 | 195.493 |
| 58 | -3.50656 | -0.0125328 | 54.3709 | 195.536 |
| 59 | -3.50656 | 0.0125328 | 54.3711 | 195.493 |
| 60 | -3.50656 | 0.0325917 | 54.3721 | 195.378 |
| 61 | -3.50656 | 0.0551734 | 54.3752 | 195.185 |
| 62 | -3.50656 | 0.0752698 | 54.3808 | 194.921 |
| 63 | -3.50656 | 0.0979139 | 54.3904 | 194.577 |
| 64 | -3.50656 | 0.12061 | 54.405 | 194.155 |
| 65 | -3.50656 | 0.140835 | 54.4248 | 193.661 |

## Shapiro-Francia Test of Normality (Continued)

Parameter: Zinc, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Total Number of Measurements = 116

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 0.03 | 0.163659 | 54.4516 | -0.602704 |
| 67 | 0.03 | 0.184017 | 54.4854 | -0.597184 |
| 68 | 0.03 | 0.207012 | 54.5283 | -0.590973 |
| 69 | 0.03 | 0.227545 | 54.5801 | -0.584147 |
| 70 | 0.03 | 0.250759 | 54.643 | -0.576624 |
| 71 | 0.03 | 0.271509 | 54.7167 | -0.568479 |
| 72 | 0.03 | 0.294992 | 54.8037 | -0.559629 |
| 73 | 0.03 | 0.316004 | 54.9036 | -0.550149 |
| 74 | 0.03 | 0.33981 | 55.019 | -0.539955 |
| 75 | 0.03 | 0.363809 | 55.1514 | -0.529041 |
| 76 | 0.03 | 0.385321 | 55.2999 | -0.517481 |
| 77 | 0.03 | 0.409735 | 55.4677 | -0.505189 |
| 78 | 0.03 | 0.431644 | 55.6541 | -0.49224 |
| 79 | 0.03 | 0.456542 | 55.8625 | -0.478543 |
| 80 | 0.03 | 0.478914 | 56.0918 | -0.464176 |
| 81 | 0.03 | 0.504372 | 56.3462 | -0.449045 |
| 82 | 0.03 | 0.52728 | 56.6243 | -0.433226 |
| 83 | 0.03 | 0.553384 | 56.9305 | -0.416625 |
| 84 | 0.03 | 0.576911 | 57.2633 | -0.399317 |
| 85 | 0.03 | 0.603765 | 57.6278 | -0.381205 |
| 86 | 0.03 | 0.631062 | 58.0261 | -0.362273 |
| 87 | 0.03 | 0.655726 | 58.4561 | -0.342601 |
| 88 | 0.03 | 0.68396 | 58.9239 | -0.322082 |
| 89 | 0.03 | 0.709522 | 59.4273 | -0.300796 |
| 90 | 0.03 | 0.738846 | 59.9732 | -0.278631 |
| 91 | 0.03 | 0.765456 | 60.5591 | -0.255667 |
| 92 | 0.03 | 0.796056 | 61.1928 | -0.231786 |
| 93 | 0.03 | 0.823893 | 61.8716 | -0.207069 |
| 94 | 0.03 | 0.855996 | 62.6043 | -0.181389 |
| 95 | 0.03 | 0.885291 | 63.3881 | -0.15483 |
| 96 | 0.03 | 0.919183 | 64.233 | -0.127255 |
| 97 | 0.03 | 0.954165 | 65.1434 | -0.0986298 |
| 98 | 0.03 | 0.986272 | 66.1161 | -0.0690417 |
| 99 | 0.03 | 1.02365 | 67.164 | -0.0383321 |
| 100 | 0.03 | 1.05812 | 68.2836 | -0.00658846 |
| 101 | 0.03 | 1.09847 | 69.4903 | 0.0263656 |
| 102 | 0.03 | 1.1359 | 70.7805 | 0.0604425 |
| 103 | 0.03 | 1.18 | 72.1729 | 0.0958425 |
| 104 | 0.03 | 1.22123 | 73.6643 | 0.132479 |
| 105 | 0.03 | 1.27024 | 75.2778 | 0.170586 |
| 106 | 0.03 | 1.31652 | 77.011 | 0.210082 |
| 107 | 0.03 | 1.3722 | 78.894 | 0.251248 |
| 108 | 0.03 | 1.4325 | 80.9461 | 0.294223 |
| 109 | 0.03 | 1.49085 | 83.1687 | 0.338949 |
| 110 | 0.03 | 1.56322 | 85.6124 | 0.385846 |
| 111 | 0.03 | 1.63524 | 88.2864 | 0.434903 |
| 112 | 0.031 | 1.72793 | 91.2721 | 0.488469 |
| 113 | 0.032 | 1.82501 | 94.6027 | 0.546869 |
| 114 | 0.033 | 1.95996 | 98.4442 | 0.611547 |
| 115 | 0.037 | 2.12007 | 102.939 | 0.68999 |
| 116 | 0.041 | 2.40892 | 108.742 | 0.788756 |

Data Set Standard Deviation = 0.00775399
Numerator = 0.622136
Denominator = 0.751875
W Statistic = 0.827446 = 0.622136 / 0.751875

5% Critical value of 0.976 exceeds 0.827446
Evidence of non-normality at 95% level of significance

## Shapiro-Francia Test of Normality

Parameter: Zinc, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Total Number of Measurements = 116

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 0.01 | -2.40892 | 5.80292 | -0.0240892 |
| 2 | 0.01 | -2.12007 | 10.2976 | -0.0452899 |
| 3 | 0.01 | -1.95996 | 14.1391 | -0.0648895 |
| 4 | 0.011 | -1.82501 | 17.4697 | -0.0849646 |
| 5 | 0.011 | -1.72793 | 20.4554 | -0.103972 |
| 6 | 0.011 | -1.63524 | 23.1294 | -0.121959 |
| 7 | 0.011 | -1.56322 | 25.5731 | -0.139155 |
| 8 | 0.012 | -1.49085 | 27.7957 | -0.157045 |
| 9 | 0.012 | -1.4325 | 29.8478 | -0.174235 |
| 10 | 0.012 | -1.3722 | 31.7308 | -0.190702 |
| 11 | 0.012 | -1.31652 | 33.464 | -0.2065 |
| 12 | 0.012 | -1.27024 | 35.0775 | -0.221743 |
| 13 | 0.013 | -1.22123 | 36.5689 | -0.237619 |
| 14 | 0.013 | -1.18 | 37.9613 | -0.252959 |
| 15 | 0.013 | -1.1359 | 39.2515 | -0.267725 |
| 16 | 0.013 | -1.09847 | 40.4582 | -0.282005 |
| 17 | 0.013 | -1.05812 | 41.5778 | -0.295761 |
| 18 | 0.014 | -1.02365 | 42.6257 | -0.310092 |
| 19 | 0.014 | -0.986272 | 43.5984 | -0.3239 |
| 20 | 0.014 | -0.954165 | 44.5088 | -0.337258 |
| 21 | 0.014 | -0.919183 | 45.3537 | -0.350127 |
| 22 | 0.014 | -0.885291 | 46.1375 | -0.362521 |
| 23 | 0.014 | -0.855996 | 46.8702 | -0.374505 |
| 24 | 0.014 | -0.823893 | 47.549 | -0.386039 |
| 25 | 0.015 | -0.796056 | 48.1827 | -0.39798 |
| 26 | 0.015 | -0.765456 | 48.7686 | -0.409462 |
| 27 | 0.015 | -0.738846 | 49.3145 | -0.420545 |
| 28 | 0.015 | -0.709522 | 49.8179 | -0.431188 |
| 29 | 0.016 | -0.68396 | 50.2857 | -0.442131 |
| 30 | 0.016 | -0.655726 | 50.7157 | -0.452623 |
| 31 | 0.016 | -0.631062 | 51.114 | -0.462719 |
| 32 | 0.017 | -0.603765 | 51.4785 | -0.472983 |
| 33 | 0.017 | -0.576911 | 51.8113 | -0.482791 |
| 34 | 0.018 | -0.553384 | 52.1175 | -0.492752 |
| 35 | 0.018 | -0.52728 | 52.3956 | -0.502243 |
| 36 | 0.018 | -0.504372 | 52.65 | -0.511322 |
| 37 | 0.019 | -0.478914 | 52.8793 | -0.520421 |
| 38 | 0.019 | -0.456542 | 53.0877 | -0.529095 |
| 39 | 0.019 | -0.431644 | 53.2741 | -0.537297 |
| 40 | 0.019 | -0.409735 | 53.4419 | -0.545081 |
| 41 | 0.019 | -0.385321 | 53.5904 | -0.552403 |
| 42 | 0.02 | -0.363809 | 53.7228 | -0.559679 |
| 43 | 0.02 | -0.33981 | 53.8382 | -0.566475 |
| 44 | 0.021 | -0.316004 | 53.9381 | -0.573111 |
| 45 | 0.021 | -0.294992 | 54.0251 | -0.579306 |
| 46 | 0.021 | -0.271509 | 54.0988 | -0.585008 |
| 47 | 0.022 | -0.250759 | 54.1617 | -0.590524 |
| 48 | 0.023 | -0.227545 | 54.2135 | -0.595758 |
| 49 | 0.023 | -0.207012 | 54.2564 | -0.600519 |
| 50 | 0.023 | -0.184017 | 54.2902 | -0.604752 |
| 51 | 0.024 | -0.163659 | 54.317 | -0.608679 |
| 52 | 0.027 | -0.140835 | 54.3368 | -0.612482 |
| 53 | 0.028 | -0.12061 | 54.3514 | -0.615859 |
| 54 | 0.028 | -0.0979139 | 54.361 | -0.618601 |
| 55 | 0.028 | -0.0752698 | 54.3666 | -0.620708 |
| 56 | 0.029 | -0.0551734 | 54.3697 | -0.622308 |
| 57 | 0.03 | -0.0325917 | 54.3707 | -0.623286 |
| 58 | 0.03 | -0.0125328 | 54.3709 | -0.623662 |
| 59 | 0.03 | 0.0125328 | 54.3711 | -0.623286 |
| 60 | 0.03 | 0.0325917 | 54.3721 | -0.622308 |
| 61 | 0.03 | 0.0551734 | 54.3752 | -0.620653 |
| 62 | 0.03 | 0.0752698 | 54.3808 | -0.618395 |
| 63 | 0.03 | 0.0979139 | 54.3904 | -0.615457 |
| 64 | 0.03 | 0.12061 | 54.405 | -0.611839 |
| 65 | 0.03 | 0.140835 | 54.4248 | -0.607614 |

**Rosner's Test for Outliers (Continued)**
**Parameter: Zinc, Dissolved**
**Background Locations**
**Original Data (Not Transformed)**
**Non-Detects Replaced-with Quantitation Limit**

-------------------------------------------
Iteration i = 3
Mean of 113 measurements = 0.0239735
Std Dev = 0.00746116
x(i+1) = 0.01 from measurement 7/27/2005 from location B-51
Rosner Statistic R = |0.01 - 0.0239735|/0.00746116 = 1.87283
Lambda(116, 4, 0.05) = 3.4148
1.87283 < 3.4148 -- No outliers detected for i = 3

-------------------------------------------
Iteration i = 2
Mean of 114 measurements = 0.0238509
Std Dev = 0.00754248
x(i+1) = 0.01 from measurement 7/7/2010 from location B-51
Rosner Statistic R = |0.01 - 0.0238509|/0.00754248 = 1.83638
Lambda(116, 3, 0.05) = 3.4216
1.83638 < 3.4216 -- No outliers detected for i = 2

-------------------------------------------
Iteration i = 1
Mean of 115 measurements = 0.0237304
Std Dev = 0.0076196
x(i+1) = 0.01 from measurement 4/6/2006 from location B-52
Rosner Statistic R = |0.01 - 0.0237304|/0.0076196 = 1.80199
Lambda(116, 2, 0.05) = 3.4216
1.80199 < 3.4216 -- No outliers detected for i = 1

-------------------------------------------
Iteration i = 0
Mean of 116 measurements = 0.0238793
Std Dev = 0.00775399
x(i+1) = 0.041 from measurement 10/10/2007 from location B-51
Rosner Statistic R = |0.041 - 0.0238793|/0.00775399 = 2.20798
Lambda(116, 1, 0.05) = 3.4248
2.20798 < 3.4248 -- No outliers detected for i = 0

**NO OUTLIERS DETECTED**

**Rosner's Test for Outliers**
**Parameter: Zinc, Dissolved**
**Background Locations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

Data set mean = 0.0238793

10 most extreme of 116 measurements
by order of magnitude difference from the mean

| | | | | |
|---|---|---|---|---|
| 1 | 10/10/2007 | B-51 | 0.041 | 0.0171207 |
| 2 | 4/6/2006 | B-52 | 0.01 J | -0.0138793 |
| 3 | 7/7/2010 | B-51 | 0.01 J | -0.0138793 |
| 4 | 7/27/2005 | B-51 | 0.01 J | -0.0138793 |
| 5 | 11/15/2001 | B-52 | 0.037 | 0.0131207 |
| 6 | 1/13/2009 | B-52 | 0.011 J | -0.0128793 |
| 7 | 10/8/2009 | B-52 | 0.011 J | -0.0128793 |
| 8 | 4/8/2009 | B-52 | 0.011 J | -0.0128793 |
| 9 | 12/8/2010 | B-52 | 0.011 J | -0.0128793 |
| 10 | 7/15/2009 | B-52 | 0.012 J | -0.0118793 |

-------------------------------------------
Iteration i = 9
Mean of 107 measurements = 0.0244673
Std Dev = 0.00698424
x(i+1) = 0.012 from measurement 7/15/2009 from location B-52
Rosner Statistic R = |0.012 - 0.0244673|/0.00698424 = 1.78506
Lambda(116, 10, 0.05) = 3.398
1.78506 < 3.398 -- No outliers detected for i = 9

-------------------------------------------
Iteration i = 8
Mean of 108 measurements = 0.0243426
Std Dev = 0.00707128
x(i+1) = 0.011 from measurement 12/8/2010 from location B-52
Rosner Statistic R = |0.011 - 0.0243426|/0.00707128 = 1.88687
Lambda(116, 9, 0.05) = 3.40136
1.88687 < 3.40136 -- No outliers detected for i = 8

-------------------------------------------
Iteration i = 7
Mean of 109 measurements = 0.0242202
Std Dev = 0.00715355
x(i+1) = 0.011 from measurement 4/8/2009 from location B-52
Rosner Statistic R = |0.011 - 0.0242202|/0.00715355 = 1.84806
Lambda(116, 8, 0.05) = 3.40472
1.84806 < 3.40472 -- No outliers detected for i = 7

-------------------------------------------
Iteration i = 6
Mean of 110 measurements = 0.0241
Std Dev = 0.00723137
x(i+1) = 0.011 from measurement 10/8/2009 from location B-52
Rosner Statistic R = |0.011 - 0.0241|/0.00723137 = 1.81155
Lambda(116, 7, 0.05) = 3.40808
1.81155 < 3.40808 -- No outliers detected for i = 6

-------------------------------------------
Iteration i = 5
Mean of 111 measurements = 0.023982
Std Dev = 0.00730502
x(i+1) = 0.011 from measurement 1/13/2009 from location B-52
Rosner Statistic R = |0.011 - 0.023982|/0.00730502 = 1.77713
Lambda(116, 6, 0.05) = 3.41144
1.77713 < 3.41144 -- No outliers detected for i = 5

-------------------------------------------
Iteration i = 4
Mean of 112 measurements = 0.0240982
Std Dev = 0.00737534
x(i+1) = 0.037 from measurement 11/15/2001 from location B-52
Rosner Statistic R = |0.037 - 0.0240982|/0.00737534 = 1.74931
Lambda(116, 5, 0.05) = 3.4148
1.74931 < 3.4148 -- No outliers detected for i = 4

## Concentrations (mg/L) - Continued

**Parameter: Zinc, Dissolved**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**
**Percent Background Non-Detects: 44.8276%**
**Total Background Measurements: 116**
**There are 3 background locations**

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| | | | 7/23/2008 | ND<0.03 | ND<0.03 |
| | | | 10/22/2008 | 0.015 J | 0.015 J |
| | | | 1/13/2009 | 0.018 J | 0.018 J |
| | | | 4/8/2009 | 0.014 J | 0.014 J |
| | | | 7/15/2009 | 0.021 J | 0.021 J |
| | | | 1/7/2010 | 0.023 J | 0.023 J |
| | | | 4/7/2010 | 0.019 J | 0.019 J |
| | | | 7/7/2010 | 0.01 J | 0.01 J |
| | | | 8/16/2011 | 0.024 J | 0.024 J |
| | | | 10/26/2011 | ND<0.03 | ND<0.03 |
| B-50 | 42 | 39 (92.8571%) | 11/15/2001 | 0.014 J | 0.014 J |
| | | | 1/16/2002 | ND<0.03 | ND<0.03 |
| | | | 4/3/2002 | ND<0.03 | ND<0.03 |
| | | | 7/2/2002 | ND<0.03 | ND<0.03 |
| | | | 10/2/2002 | ND<0.03 | ND<0.03 |
| | | | 1/8/2003 | ND<0.03 | ND<0.03 |
| | | | 4/2/2003 | ND<0.03 | ND<0.03 |
| | | | 7/23/2003 | ND<0.03 | ND<0.03 |
| | | | 10/2/2003 | ND<0.03 | ND<0.03 |
| | | | 1/7/2004 | ND<0.03 | ND<0.03 |
| | | | 4/7/2004 | ND<0.03 | ND<0.03 |
| | | | 7/13/2004 | ND<0.03 | ND<0.03 |
| | | | 10/6/2004 | ND<0.03 | ND<0.03 |
| | | | 1/6/2005 | ND<0.03 | ND<0.03 |
| | | | 4/6/2005 | ND<0.03 | ND<0.03 |
| | | | 7/27/2005 | ND<0.03 | ND<0.03 |
| | | | 10/13/2005 | ND<0.03 | ND<0.03 |
| | | | 1/5/2006 | ND<0.03 | ND<0.03 |
| | | | 4/6/2006 | ND<0.03 | ND<0.03 |
| | | | 7/25/2006 | ND<0.03 | ND<0.03 |
| | | | 10/11/2006 | ND<0.03 | ND<0.03 |
| | | | 1/4/2007 | ND<0.03 | ND<0.03 |
| | | | 4/4/2007 | ND<0.03 | ND<0.03 |
| | | | 7/12/2007 | ND<0.03 | ND<0.03 |
| | | | 10/10/2007 | 0.012 J | 0.012 J |
| | | | 1/16/2008 | ND<0.03 | ND<0.03 |
| | | | 4/3/2008 | ND<0.03 | ND<0.03 |
| | | | 7/23/2008 | ND<0.03 | ND<0.03 |
| | | | 10/22/2008 | ND<0.03 | ND<0.03 |
| | | | 1/13/2009 | ND<0.03 | ND<0.03 |
| | | | 4/8/2009 | ND<0.03 | ND<0.03 |
| | | | 7/15/2009 | ND<0.03 | ND<0.03 |
| | | | 10/8/2009 | ND<0.03 | ND<0.03 |
| | | | 1/7/2010 | ND<0.03 | ND<0.03 |
| | | | 4/7/2010 | ND<0.03 | ND<0.03 |
| | | | 7/7/2010 | ND<0.03 | ND<0.03 |
| | | | 12/8/2010 | ND<0.03 | ND<0.03 |
| | | | 2/3/2011 | ND<0.03 | ND<0.03 |
| | | | 4/13/2011 | ND<0.03 | ND<0.03 |
| | | | 8/16/2011 | 0.014 J | 0.014 J |
| | | | 10/26/2011 | ND<0.03 | ND<0.03 |
| | | | 1/18/2012 | ND<0.03 | ND<0.03 |

Concentrations (mg/L)
Parameter: Zinc, Dissolved
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 44.8276%
Total Background Measurements: 116
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-52 | 42 | 4 (9.52381%) | 11/15/2001 | 0.037 | 0.037 |
| | | | 1/16/2002 | 0.032 | 0.032 |
| | | | 4/3/2002 | 0.03 | 0.03 |
| | | | 7/2/2002 | 0.018 J | 0.018 J |
| | | | 10/2/2002 | 0.017 J | 0.017 J |
| | | | 1/8/2003 | 0.018 J | 0.018 J |
| | | | 4/2/2003 | 0.013 J | 0.013 J |
| | | | 7/23/2003 | 0.023 J | 0.023 J |
| | | | 10/2/2003 | 0.013 J | 0.013 J |
| | | | 1/7/2004 | 0.029 J | 0.029 J |
| | | | 4/7/2004 | 0.03 | 0.03 |
| | | | 7/13/2004 | 0.021 J | 0.021 J |
| | | | 10/6/2004 | 0.03 | 0.03 |
| | | | 1/6/2005 | 0.022 J | 0.022 J |
| | | | 4/6/2005 | 0.028 J | 0.028 J |
| | | | 7/27/2005 | 0.019 J | 0.019 J |
| | | | 10/13/2005 | 0.012 J | 0.012 J |
| | | | 1/5/2006 | 0.019 J | 0.019 J |
| | | | 4/6/2006 | 0.01 J | 0.01 J |
| | | | 7/25/2006 | 0.012 J | 0.012 J |
| | | | 10/11/2006 | 0.015 J | 0.015 J |
| | | | 1/4/2007 | 0.016 J | 0.016 J |
| | | | 4/4/2007 | 0.015 J | 0.015 J |
| | | | 7/12/2007 | ND<0.03 | ND<0.03 |
| | | | 10/10/2007 | 0.031 | 0.031 |
| | | | 1/16/2008 | ND<0.03 | ND<0.03 |
| | | | 4/3/2008 | 0.014 J | 0.014 J |
| | | | 7/23/2008 | 0.016 J | 0.016 J |
| | | | 10/22/2008 | 0.015 J | 0.015 J |
| | | | 1/13/2009 | 0.011 J | 0.011 J |
| | | | 4/8/2009 | 0.011 J | 0.011 J |
| | | | 7/15/2009 | 0.012 J | 0.012 J |
| | | | 10/8/2009 | 0.011 J | 0.011 J |
| | | | 1/7/2010 | ND<0.03 | ND<0.03 |
| | | | 4/7/2010 | 0.014 J | 0.014 J |
| | | | 7/7/2010 | ND<0.03 | ND<0.03 |
| | | | 12/8/2010 | 0.011 J | 0.011 J |
| | | | 2/3/2011 | 0.019 J | 0.019 J |
| | | | 4/13/2011 | 0.023 J | 0.023 J |
| | | | 8/16/2011 | 0.027 J | 0.027 J |
| | | | 10/26/2011 | 0.016 J | 0.016 J |
| | | | 1/18/2012 | 0.028 J | 0.028 J |
| B-51 | 32 | 9 (28.125%) | 11/15/2001 | 0.028 J | 0.028 J |
| | | | 10/2/2002 | ND<0.03 | ND<0.03 |
| | | | 1/8/2003 | ND<0.03 | ND<0.03 |
| | | | 4/2/2003 | 0.013 J | 0.013 J |
| | | | 7/23/2003 | ND<0.03 | ND<0.03 |
| | | | 10/2/2003 | 0.033 | 0.033 |
| | | | 1/7/2004 | 0.013 J | 0.013 J |
| | | | 4/7/2004 | 0.02 J | 0.02 J |
| | | | 7/13/2004 | ND<0.03 | ND<0.03 |
| | | | 10/6/2004 | 0.021 J | 0.021 J |
| | | | 1/6/2005 | 0.014 J | 0.014 J |
| | | | 4/6/2005 | ND<0.03 | ND<0.03 |
| | | | 7/27/2005 | 0.01 J | 0.01 J |
| | | | 10/13/2005 | ND<0.03 | ND<0.03 |
| | | | 1/5/2006 | 0.019 J | 0.019 J |
| | | | 4/6/2006 | ND<0.03 | ND<0.03 |
| | | | 7/25/2006 | 0.012 J | 0.012 J |
| | | | 10/11/2006 | 0.017 J | 0.017 J |
| | | | 1/4/2007 | 0.02 J | 0.02 J |
| | | | 4/4/2007 | 0.013 J | 0.013 J |
| | | | 7/12/2007 | 0.014 J | 0.014 J |
| | | | 10/10/2007 | 0.041 | 0.041 |

**Non-Parametric Prediction Interval**
**Inter-Well Comparison**
**Parameter: Manganese, Dissolved**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 103
**Maximum Background Value = 4.42**
Confidence Level = 99%
False Positive Rate = 1%

| Location | Date | Count | Mean | Significant |
|---|---|---|---|---|
| B-30A | 4/4/2012 | 1 | 1.23 | FALSE |
| B-32 | 4/4/2012 | 1 | 1.91 | FALSE |
| DM-7 | 4/4/2012 | 1 | 0.05 | FALSE |
| DM-6 | 4/4/2012 | 1 | 0.03 | FALSE |
| B-31 | 4/4/2012 | 1 | 0.02 | FALSE |
| DM-5 | 4/4/2012 | 1 | 0.48 | FALSE |
| DM-1 | 4/4/2012 | 1 | 0.27 | FALSE |

## Shapiro-Francia Test of Normality (Continued)

**Parameter: Manganese, Dissolved**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Natural Logarithm Transformation**
**Non-Detects Replaced with 1/2 LOQ**
**Total Number of Measurements = 103**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 0.576613 | 0.345126 | 48.5642 | 139.173 |
| 67 | 0.815365 | 0.371856 | 48.7025 | 139.476 |
| 68 | 0.883768 | 0.396142 | 48.8594 | 139.826 |
| 69 | 0.920283 | 0.423405 | 49.0387 | 140.216 |
| 70 | 0.95935 | 0.450985 | 49.2421 | 140.649 |
| 71 | 0.963174 | 0.476105 | 49.4688 | 141.107 |
| 72 | 0.963174 | 0.504372 | 49.7232 | 141.593 |
| 73 | 0.963174 | 0.530162 | 50.0042 | 142.104 |
| 74 | 1.0043 | 0.559237 | 50.317 | 142.665 |
| 75 | 1.04732 | 0.588793 | 50.6637 | 143.282 |
| 76 | 1.07158 | 0.615839 | 51.0429 | 143.942 |
| 77 | 1.08181 | 0.646431 | 51.4608 | 144.641 |
| 78 | 1.09861 | 0.67449 | 51.9157 | 145.382 |
| 79 | 1.11186 | 0.706302 | 52.4146 | 146.167 |
| 80 | 1.19089 | 0.738846 | 52.9605 | 147.047 |
| 81 | 1.20597 | 0.768821 | 53.5516 | 147.974 |
| 82 | 1.22083 | 0.802956 | 54.1963 | 148.955 |
| 83 | 1.22964 | 0.838054 | 54.8986 | 149.985 |
| 84 | 1.23547 | 0.87055 | 55.6565 | 151.061 |
| 85 | 1.24703 | 0.907769 | 56.4805 | 152.193 |
| 86 | 1.25276 | 0.942375 | 57.3686 | 153.373 |
| 87 | 1.25846 | 0.982202 | 58.3333 | 154.609 |
| 88 | 1.26413 | 1.02365 | 59.3812 | 155.903 |
| 89 | 1.31641 | 1.06252 | 60.5102 | 157.302 |
| 90 | 1.335 | 1.10768 | 61.7371 | 158.781 |
| 91 | 1.33763 | 1.15035 | 63.0604 | 160.32 |
| 92 | 1.35067 | 1.20036 | 64.5013 | 161.941 |
| 93 | 1.35584 | 1.25357 | 66.0727 | 163.641 |
| 94 | 1.37118 | 1.30469 | 67.7749 | 165.43 |
| 95 | 1.37372 | 1.36581 | 69.6403 | 167.306 |
| 96 | 1.41099 | 1.4325 | 71.6924 | 169.327 |
| 97 | 1.41099 | 1.49852 | 73.938 | 171.441 |
| 98 | 1.41342 | 1.58047 | 76.4358 | 173.675 |
| 99 | 1.43746 | 1.66456 | 79.2066 | 176.068 |
| 100 | 1.46326 | 1.77438 | 82.355 | 178.664 |
| 101 | 1.47018 | 1.91103 | 86.007 | 181.474 |
| 102 | 1.48614 | 2.07485 | 90.312 | 184.557 |
| 103 | 1.48614 | 2.36561 | 95.9082 | 188.073 |

Data Set Standard Deviation = 2.10883
Numerator = 35371.5
Denominator = 43504.9
W Statistic = 0.813046 = 35371.5 / 43504.9

5% Critical value of 0.976 exceeds 0.813046
Evidence of non-normality at 95% level of significance

**Shapiro-Francia Test of Normality**
**Parameter: Manganese, Dissolved**
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Non-Detects Replaced with 1/2 LOQ
Total Number of Measurements = 103

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | -3.91202 | -2.36561 | 5.59613 | 9.25434 |
| 2 | -3.91202 | -2.07485 | 9.90113 | 17.3712 |
| 3 | -3.91202 | -1.91103 | 13.5532 | 24.8472 |
| 4 | -3.91202 | -1.77438 | 16.7016 | 31.7886 |
| 5 | -3.91202 | -1.66456 | 19.4723 | 38.3004 |
| 6 | -3.91202 | -1.58047 | 21.9702 | 44.4832 |
| 7 | -3.91202 | -1.49852 | 24.2158 | 50.3454 |
| 8 | -3.91202 | -1.4325 | 26.2678 | 55.9494 |
| 9 | -3.91202 | -1.36581 | 28.1333 | 61.2925 |
| 10 | -3.91202 | -1.30469 | 29.8355 | 66.3965 |
| 11 | -3.50656 | -1.25357 | 31.4069 | 70.7922 |
| 12 | -3.50656 | -1.20036 | 32.8478 | 75.0013 |
| 13 | -3.50656 | -1.15035 | 34.1711 | 79.0351 |
| 14 | -3.50656 | -1.10768 | 35.398 | 82.9192 |
| 15 | -3.50656 | -1.06252 | 36.527 | 86.645 |
| 16 | -3.50656 | -1.02365 | 37.5748 | 90.2345 |
| 17 | -3.50656 | -0.982202 | 38.5396 | 93.6786 |
| 18 | -3.50656 | -0.942375 | 39.4276 | 96.9831 |
| 19 | -3.50656 | -0.907769 | 40.2517 | 100.166 |
| 20 | -3.50656 | -0.87055 | 41.0095 | 103.219 |
| 21 | -3.21888 | -0.838054 | 41.7119 | 105.916 |
| 22 | -3.21888 | -0.802956 | 42.3566 | 108.501 |
| 23 | -3.21888 | -0.768821 | 42.9477 | 110.976 |
| 24 | -3.21888 | -0.738846 | 43.4936 | 113.354 |
| 25 | -3.21888 | -0.706302 | 43.9924 | 115.628 |
| 26 | -3.21888 | -0.67449 | 44.4474 | 117.799 |
| 27 | -3.21888 | -0.646431 | 44.8652 | 119.879 |
| 28 | -3.21888 | -0.615839 | 45.2445 | 121.862 |
| 29 | -2.99573 | -0.588793 | 45.5912 | 123.626 |
| 30 | -2.99573 | -0.559237 | 45.9039 | 125.301 |
| 31 | -2.99573 | -0.530162 | 46.185 | 126.889 |
| 32 | -2.99573 | -0.504372 | 46.4394 | 128.4 |
| 33 | -2.99573 | -0.476105 | 46.6661 | 129.826 |
| 34 | -2.99573 | -0.450985 | 46.8695 | 131.177 |
| 35 | -2.99573 | -0.423405 | 47.0487 | 132.446 |
| 36 | -2.99573 | -0.396142 | 47.2057 | 133.633 |
| 37 | -2.99573 | -0.371856 | 47.3439 | 134.747 |
| 38 | -2.99573 | -0.345126 | 47.463 | 135.781 |
| 39 | -2.99573 | -0.318639 | 47.5646 | 136.735 |
| 40 | -2.99573 | -0.294992 | 47.6516 | 137.619 |
| 41 | -2.99573 | -0.268908 | 47.7239 | 138.424 |
| 42 | -2.99573 | -0.24559 | 47.7842 | 139.16 |
| 43 | -2.99573 | -0.219834 | 47.8325 | 139.819 |
| 44 | -2.81341 | -0.194225 | 47.8703 | 140.365 |
| 45 | -2.81341 | -0.171285 | 47.8996 | 140.847 |
| 46 | -2.81341 | -0.1459 | 47.9209 | 141.257 |
| 47 | -2.81341 | -0.123135 | 47.9361 | 141.604 |
| 48 | -2.81341 | -0.0979139 | 47.9456 | 141.879 |
| 49 | -2.81341 | -0.0727562 | 47.9509 | 142.084 |
| 50 | -2.65926 | -0.0501541 | 47.9535 | 142.217 |
| 51 | -2.65926 | -0.0250691 | 47.9541 | 142.284 |
| 52 | -2.40795 | 0 | 47.9541 | 142.284 |
| 53 | -2.40795 | 0.0250691 | 47.9547 | 142.224 |
| 54 | -2.30259 | 0.0501541 | 47.9572 | 142.108 |
| 55 | -2.12026 | 0.0727562 | 47.9625 | 141.954 |
| 56 | -2.04022 | 0.0979139 | 47.9721 | 141.754 |
| 57 | -1.96611 | 0.123135 | 47.9873 | 141.512 |
| 58 | -1.96611 | 0.1459 | 48.0086 | 141.225 |
| 59 | -1.89712 | 0.171285 | 48.0379 | 140.9 |
| 60 | -1.83258 | 0.194225 | 48.0756 | 140.544 |
| 61 | -1.83258 | 0.219834 | 48.1239 | 140.142 |
| 62 | -1.83258 | 0.24559 | 48.1843 | 139.691 |
| 63 | -1.60944 | 0.268908 | 48.2566 | 139.259 |
| 64 | -1.17118 | 0.294992 | 48.3436 | 138.913 |
| 65 | 0.19062 | 0.318639 | 48.4451 | 138.974 |

## Shapiro-Francia Test of Normality (Continued)

**Parameter: Manganese, Dissolved**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with 1/2 LOQ**
**Total Number of Measurements = 103**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 1.78 | 0.345126 | 48.5642 | 0.103305 |
| 67 | 2.26 | 0.371856 | 48.7025 | 0.9437 |
| 68 | 2.42 | 0.396142 | 48.8594 | 1.90236 |
| 69 | 2.51 | 0.423405 | 49.0387 | 2.96511 |
| 70 | 2.61 | 0.450985 | 49.2421 | 4.14218 |
| 71 | 2.62 | 0.476105 | 49.4688 | 5.38958 |
| 72 | 2.62 | 0.504372 | 49.7232 | 6.71103 |
| 73 | 2.62 | 0.530162 | 50.0042 | 8.10005 |
| 74 | 2.73 | 0.559237 | 50.317 | 9.62677 |
| 75 | 2.85 | 0.588793 | 50.6637 | 11.3048 |
| 76 | 2.92 | 0.615839 | 51.0429 | 13.1031 |
| 77 | 2.95 | 0.646431 | 51.4608 | 15.0101 |
| 78 | 3 | 0.67449 | 51.9157 | 17.0335 |
| 79 | 3.04 | 0.706302 | 52.4146 | 19.1807 |
| 80 | 3.29 | 0.738846 | 52.9605 | 21.6115 |
| 81 | 3.34 | 0.768821 | 53.5516 | 24.1793 |
| 82 | 3.39 | 0.802956 | 54.1963 | 26.9014 |
| 83 | 3.42 | 0.838054 | 54.8986 | 29.7675 |
| 84 | 3.44 | 0.87055 | 55.6565 | 32.7622 |
| 85 | 3.48 | 0.907769 | 56.4805 | 35.9212 |
| 86 | 3.5 | 0.942375 | 57.3686 | 39.2196 |
| 87 | 3.52 | 0.982202 | 58.3333 | 42.6769 |
| 88 | 3.54 | 1.02365 | 59.3812 | 46.3006 |
| 89 | 3.73 | 1.06252 | 60.5102 | 50.2638 |
| 90 | 3.8 | 1.10768 | 61.7371 | 54.473 |
| 91 | 3.81 | 1.15035 | 63.0604 | 58.8559 |
| 92 | 3.86 | 1.20036 | 64.5013 | 63.4892 |
| 93 | 3.88 | 1.25357 | 66.0727 | 68.3531 |
| 94 | 3.94 | 1.30469 | 67.7749 | 73.4935 |
| 95 | 3.95 | 1.36581 | 69.6403 | 78.8885 |
| 96 | 4.1 | 1.4325 | 71.6924 | 84.7617 |
| 97 | 4.1 | 1.49852 | 73.938 | 90.9057 |
| 98 | 4.11 | 1.58047 | 76.4358 | 97.4014 |
| 99 | 4.21 | 1.66456 | 79.2066 | 104.409 |
| 100 | 4.32 | 1.77438 | 82.355 | 112.074 |
| 101 | 4.35 | 1.91103 | 86.007 | 120.387 |
| 102 | 4.42 | 2.07485 | 90.312 | 129.558 |
| 103 | 4.42 | 2.36561 | 95.9082 | 140.014 |

Data Set Standard Deviation = 1.66086
Numerator = 19604
Denominator = 26985.1
W Statistic = 0.726476 = 19604 / 26985.1

5% Critical value of 0.976 exceeds 0.726476
Evidence of non-normality at 95% level of significance

## Shapiro-Francia Test of Normality

Parameter: Manganese, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Non-Detects Replaced with 1/2 LOQ
Total Number of Measurements = 103

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 0.02 | -2.36561 | 5.59613 | -0.0473123 |
| 2 | 0.02 | -2.07485 | 9.90113 | -0.0888092 |
| 3 | 0.02 | -1.91103 | 13.5532 | -0.12703 |
| 4 | 0.02 | -1.77438 | 16.7016 | -0.162517 |
| 5 | 0.02 | -1.66456 | 19.4723 | -0.195809 |
| 6 | 0.02 | -1.58047 | 21.9702 | -0.227418 |
| 7 | 0.02 | -1.49852 | 24.2158 | -0.257388 |
| 8 | 0.02 | -1.4325 | 26.2678 | -0.286038 |
| 9 | 0.02 | -1.36581 | 28.1333 | -0.313354 |
| 10 | 0.02 | -1.30469 | 29.8355 | -0.339448 |
| 11 | 0.03 | -1.25357 | 31.4069 | -0.377055 |
| 12 | 0.03 | -1.20036 | 32.8478 | -0.413066 |
| 13 | 0.03 | -1.15035 | 34.1711 | -0.447576 |
| 14 | 0.03 | -1.10768 | 35.398 | -0.480807 |
| 15 | 0.03 | -1.06252 | 36.527 | -0.512682 |
| 16 | 0.03 | -1.02365 | 37.5748 | -0.543392 |
| 17 | 0.03 | -0.982202 | 38.5396 | -0.572858 |
| 18 | 0.03 | -0.942375 | 39.4276 | -0.601129 |
| 19 | 0.03 | -0.907769 | 40.2517 | -0.628362 |
| 20 | 0.03 | -0.87055 | 41.0095 | -0.654479 |
| 21 | 0.04 | -0.838054 | 41.7119 | -0.688001 |
| 22 | 0.04 | -0.802956 | 42.3566 | -0.720119 |
| 23 | 0.04 | -0.768821 | 42.9477 | -0.750872 |
| 24 | 0.04 | -0.738846 | 43.4936 | -0.780426 |
| 25 | 0.04 | -0.706302 | 43.9924 | -0.808678 |
| 26 | 0.04 | -0.67449 | 44.4474 | -0.835658 |
| 27 | 0.04 | -0.646431 | 44.8652 | -0.861515 |
| 28 | 0.04 | -0.615839 | 45.2445 | -0.886149 |
| 29 | 0.05 | -0.588793 | 45.5912 | 0.915588 |
| 30 | 0.05 | -0.559237 | 45.9039 | -0.94355 |
| 31 | 0.05 | -0.530162 | 46.185 | -0.970058 |
| 32 | 0.05 | -0.504372 | 46.4394 | -0.995277 |
| 33 | 0.05 | -0.476105 | 46.6661 | -1.01908 |
| 34 | 0.05 | -0.450985 | 46.8695 | -1.04163 |
| 35 | 0.05 | -0.423405 | 47.0487 | -1.0628 |
| 36 | 0.05 | -0.396142 | 47.2057 | -1.08261 |
| 37 | 0.05 | -0.371856 | 47.3439 | -1.1012 |
| 38 | 0.05 | -0.345126 | 47.463 | -1.11846 |
| 39 | 0.05 | -0.318639 | 47.5646 | -1.13439 |
| 40 | 0.05 | -0.294992 | 47.6516 | -1.14914 |
| 41 | 0.05 | -0.268908 | 47.7239 | -1.16258 |
| 42 | 0.05 | -0.24559 | 47.7842 | -1.17486 |
| 43 | 0.05 | -0.219834 | 47.8325 | -1.18586 |
| 44 | 0.06 | -0.194225 | 47.8703 | -1.19751 |
| 45 | 0.06 | -0.171285 | 47.8996 | -1.20779 |
| 46 | 0.06 | -0.1459 | 47.9209 | -1.21654 |
| 47 | 0.06 | -0.123135 | 47.9361 | -1.22393 |
| 48 | 0.06 | -0.0979139 | 47.9456 | -1.2298 |
| 49 | 0.06 | -0.0727562 | 47.9509 | -1.23417 |
| 50 | 0.07 | -0.0501541 | 47.9535 | -1.23768 |
| 51 | 0.07 | -0.0250691 | 47.9541 | -1.23943 |
| 52 | 0.09 | 0 | 47.9541 | -1.23943 |
| 53 | 0.09 | 0.0250691 | 47.9547 | -1.23718 |
| 54 | 0.1 | 0.0501541 | 47.9572 | -1.23216 |
| 55 | 0.12 | 0.0727562 | 47.9625 | -1.22343 |
| 56 | 0.13 | 0.0979139 | 47.9721 | -1.2107 |
| 57 | 0.14 | 0.123135 | 47.9873 | -1.19346 |
| 58 | 0.14 | 0.1459 | 48.0086 | -1.17304 |
| 59 | 0.15 | 0.171285 | 48.0379 | -1.14735 |
| 60 | 0.16 | 0.194225 | 48.0756 | -1.11627 |
| 61 | 0.16 | 0.219834 | 48.1239 | -1.0811 |
| 62 | 0.16 | 0.24559 | 48.1843 | -1.0418 |
| 63 | 0.2 | 0.268908 | 48.2566 | -0.98802 |
| 64 | 0.31 | 0.294992 | 48.3436 | -0.896572 |
| 65 | 1.21 | 0.318639 | 48.4451 | -0.511019 |

**Rosner's Test for Outliers (Continued)**
**Parameter: Manganese, Dissolved**
**Background Locations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

---------------------------------------------

Iteration i = 3
Mean of 100 measurements = 1.2139
Std Dev = 1.59109
x(i+1) = 4.32 from measurement 11/15/2001 from location B-50
Rosner Statistic R = |4.32 - 1.2139|/1.59109 = 1.95218
Lambda(103, 4, 0.05) = 3.3784
1.95218 < 3.3784 -- No outliers detected for i = 3

---------------------------------------------

Iteration i = 2
Mean of 101 measurements = 1.24495
Std Dev = 1.61358
x(i+1) = 4.35 from measurement 1/6/2005 from location B-50
Rosner Statistic R = |4.35 - 1.24495|/1.61358 = 1.92432
Lambda(103, 3, 0.05) = 3.3878
1.92432 < 3.3878 -- No outliers detected for i = 2

---------------------------------------------

Iteration i = 1
Mean of 102 measurements = 1.27608
Std Dev = 1.63606
x(i+1) = 4.42 from measurement 4/7/2004 from location B-50
Rosner Statistic R = |4.42 - 1.27608|/1.63606 = 1.92164
Lambda(103, 2, 0.05) = 3.3878
1.92164 < 3.3878 -- No outliers detected for i = 1

---------------------------------------------

Iteration i = 0
Mean of 103 measurements = 1.3066
Std Dev = 1.65723
x(i+1) = 4.42 from measurement 7/13/2004 from location B-50
Rosner Statistic R = |4.42 - 1.3066|/1.65723 = 1.87867
Lambda(103, 1, 0.05) = 3.3884
1.87867 < 3.3884 -- No outliers detected for i = 0

**NO OUTLIERS DETECTED**

**Rosner's Test for Outliers**
**Parameter: Manganese, Dissolved**
**Background Locations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

Data set mean = 1.3066

10 most extreme of 103 measurements
by order of magnitude difference from the mean

| | | | | |
|---|---|---|---|---|
| 1 | 7/13/2004 | B-50 | 4.42 | 3.1134 |
| 2 | 4/7/2004 | B-50 | 4.42 | 3.1134 |
| 3 | 1/6/2005 | B-50 | 4.35 | 3.0434 |
| 4 | 11/15/2001 | B-50 | 4.32 | 3.0134 |
| 5 | 10/6/2004 | B-50 | 4.21 | 2.9034 |
| 6 | 4/4/2007 | B-50 | 4.11 | 2.8034 |
| 7 | 10/2/2003 | B-50 | 4.1 | 2.7934 |
| 8 | 1/7/2004 | B-50 | 4.1 | 2.7934 |
| 9 | 4/6/2005 | B-50 | 3.95 | 2.6434 |
| 10 | 1/5/2006 | B-50 | 3.94 | 2.6334 |

--------------------------------------------
Iteration i = 9
Mean of 94 measurements = 1.02766
Std Dev = 1.4525
x(i+1) = 3.94 from measurement 1/5/2006 from location B-50
Rosner Statistic R = |3.94 - 1.02766|/1.4525 = 2.00505
Lambda(103, 10, 0.05) = 3.359
2.00505 < 3.359 -- No outliers detected for i = 9

--------------------------------------------
Iteration i = 8
Mean of 95 measurements = 1.05842
Std Dev = 1.47554
x(i+1) = 3.95 from measurement 4/6/2005 from location B-50
Rosner Statistic R = |3.95 - 1.05842|/1.47554 = 1.95967
Lambda(103, 9, 0.05) = 3.36288
1.95967 < 3.36288 -- No outliers detected for i = 8

--------------------------------------------
Iteration i = 7
Mean of 96 measurements = 1.0901
Std Dev = 1.50022
x(i+1) = 4.1 from measurement 1/7/2004 from location B-50
Rosner Statistic R = |4.1 - 1.0901|/1.50022 = 2.0063
Lambda(103, 8, 0.05) = 3.36676
2.0063 < 3.36676 -- No outliers detected for i = 7

--------------------------------------------
Iteration i = 6
Mean of 97 measurements = 1.12113
Std Dev = 1.52336
x(i+1) = 4.1 from measurement 10/2/2003 from location B-50
Rosner Statistic R = |4.1 - 1.12113|/1.52336 = 1.95546
Lambda(103, 7, 0.05) = 3.37064
1.95546 < 3.37064 -- No outliers detected for i = 6

--------------------------------------------
Iteration i = 5
Mean of 98 measurements = 1.15163
Std Dev = 1.54527
x(i+1) = 4.11 from measurement 4/4/2007 from location B-50
Rosner Statistic R = |4.11 - 1.15163|/1.54527 = 1.91447
Lambda(103, 6, 0.05) = 3.37452
1.91447 < 3.37452 -- No outliers detected for i = 5

--------------------------------------------
Iteration i = 4
Mean of 99 measurements = 1.18253
Std Dev = 1.56779
x(i+1) = 4.21 from measurement 10/6/2004 from location B-50
Rosner Statistic R = |4.21 - 1.18253|/1.56779 = 1.93105
Lambda(103, 5, 0.05) = 3.3784
1.93105 < 3.3784 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Manganese, Dissolved
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 9.7087%
Total Background Measurements: 103
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-50 | 37 | 0 (0%) | 11/15/2001 | 4.32 | 4.32 |
| | | | 4/3/2002 | 3.88 | 3.88 |
| | | | 4/2/2003 | 3.8 | 3.8 |
| | | | 10/2/2003 | 4.1 | 4.1 |
| | | | 1/7/2004 | 4.1 | 4.1 |
| | | | 4/7/2004 | 4.42 | 4.42 |
| | | | 7/13/2004 | 4.42 | 4.42 |
| | | | 10/6/2004 | 4.21 | 4.21 |
| | | | 1/6/2005 | 4.35 | 4.35 |
| | | | 4/6/2005 | 3.95 | 3.95 |
| | | | 7/27/2005 | 3.52 | 3.52 |
| | | | 10/13/2005 | 3.73 | 3.73 |
| | | | 1/5/2006 | 3.94 | 3.94 |
| | | | 4/6/2006 | 3.39 | 3.39 |
| | | | 7/25/2006 | 3.42 | 3.42 |
| | | | 10/11/2006 | 3.48 | 3.48 |
| | | | 1/4/2007 | 3.81 | 3.81 |
| | | | 4/4/2007 | 4.11 | 4.11 |
| | | | 7/12/2007 | 3.86 | 3.86 |
| | | | 10/10/2007 | 3.29 | 3.29 |
| | | | 1/16/2008 | 2.92 | 2.92 |
| | | | 4/3/2008 | 3.44 | 3.44 |
| | | | 7/23/2008 | 2.61 | 2.61 |
| | | | 10/22/2008 | 2.73 | 2.73 |
| | | | 1/13/2009 | 3.04 | 3.04 |
| | | | 4/8/2009 | 3.5 | 3.5 |
| | | | 7/15/2009 | 2.62 | 2.62 |
| | | | 10/8/2009 | 2.26 | 2.26 |
| | | | 1/7/2010 | 3.34 | 3.34 |
| | | | 4/7/2010 | 3.54 | 3.54 |
| | | | 7/7/2010 | 2.85 | 2.85 |
| | | | 12/8/2010 | 2.62 | 2.62 |
| | | | 2/3/2011 | 2.42 | 2.42 |
| | | | 4/13/2011 | 2.51 | 2.51 |
| | | | 8/16/2011 | 3 | 3 |
| | | | 10/26/2011 | 2.62 | 2.62 |
| | | | 1/18/2012 | 2.95 | 2.95 |

## Concentrations (mg/L)

**Parameter: Manganese, Dissolved**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**
**Percent Background Non-Detects: 9.7087%**
**Total Background Measurements: 103**
**There are 3 background locations**

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-52 | 37 | 1 (2.7027%) | 11/15/2001 | 1.78 | 1.78 |
| | | | 4/3/2002 | 1.21 | 1.21 |
| | | | 4/2/2003 | 0.2 | 0.2 |
| | | | 10/2/2003 | 0.16 | 0.16 |
| | | | 1/7/2004 | 0.15 | 0.15 |
| | | | 4/7/2004 | 0.16 | 0.16 |
| | | | 7/13/2004 | 0.12 | 0.12 |
| | | | 10/6/2004 | 0.14 | 0.14 |
| | | | 1/6/2005 | 0.16 | 0.16 |
| | | | 4/6/2005 | 0.13 | 0.13 |
| | | | 7/27/2005 | 0.14 | 0.14 |
| | | | 10/13/2005 | 0.04 J | 0.04 J |
| | | | 1/5/2006 | 0.09 J | 0.09 J |
| | | | 4/6/2006 | 0.03 J | 0.03 J |
| | | | 7/25/2006 | 0.05 J | 0.05 J |
| | | | 10/11/2006 | 0.04 J | 0.04 J |
| | | | 1/4/2007 | 0.1 | 0.1 |
| | | | 4/4/2007 | 0.07 J | 0.07 J |
| | | | 7/12/2007 | 0.06 J | 0.06 J |
| | | | 10/10/2007 | 0.06 J | 0.06 J |
| | | | 1/16/2008 | 0.04 J | 0.04 J |
| | | | 4/3/2008 | 0.07 J | 0.07 J |
| | | | 7/23/2008 | 0.06 J | 0.06 J |
| | | | 10/22/2008 | 0.04 J | 0.04 J |
| | | | 1/13/2009 | 0.09 J | 0.09 J |
| | | | 4/8/2009 | 0.03 J | 0.03 J |
| | | | 7/15/2009 | 0.03 J | 0.03 J |
| | | | 10/8/2009 | 0.05 J | 0.05 J |
| | | | 1/7/2010 | 0.02 J | 0.02 J |
| | | | 4/7/2010 | ND<0.1 | ND<0.1 |
| | | | 7/7/2010 | 0.03 J | 0.03 J |
| | | | 12/8/2010 | 0.02 J | 0.02 J |
| | | | 2/3/2011 | 0.04 J | 0.04 J |
| | | | 4/13/2011 | 0.02 J | 0.02 J |
| | | | 8/16/2011 | 0.03 J | 0.03 J |
| | | | 10/26/2011 | 0.06 | 0.06 |
| | | | 1/18/2012 | 0.02 J | 0.02 J |
| B-51 | 29 | 9 (31.0345%) | 11/15/2001 | 0.31 | 0.31 |
| | | | 4/2/2003 | 0.06 J | 0.06 J |
| | | | 10/2/2003 | 0.06 J | 0.06 J |
| | | | 1/7/2004 | 0.05 J | 0.05 J |
| | | | 4/7/2004 | 0.05 J | 0.05 J |
| | | | 7/13/2004 | 0.03 J | 0.03 J |
| | | | 10/6/2004 | 0.04 J | 0.04 J |
| | | | 1/6/2005 | 0.02 J | 0.02 J |
| | | | 4/6/2005 | ND<0.1 | ND<0.1 |
| | | | 7/27/2005 | 0.04 J | 0.04 J |
| | | | 10/13/2005 | 0.02 J | 0.02 J |
| | | | 1/5/2006 | 0.05 J | 0.05 J |
| | | | 4/6/2006 | ND<0.1 | ND<0.1 |
| | | | 7/25/2006 | 0.03 J | 0.03 J |
| | | | 10/11/2006 | ND<0.1 | ND<0.1 |
| | | | 1/4/2007 | 0.03 J | 0.03 J |
| | | | 4/4/2007 | 0.03 J | 0.03 J |
| | | | 7/12/2007 | 0.02 J | 0.02 J |
| | | | 10/10/2007 | 0.02 J | 0.02 J |
| | | | 7/23/2008 | ND<0.1 | ND<0.1 |
| | | | 10/22/2008 | ND<0.1 | ND<0.1 |
| | | | 1/13/2009 | 0.04 J | 0.04 J |
| | | | 4/8/2009 | ND<0.1 | ND<0.1 |
| | | | 7/15/2009 | ND<0.1 | ND<0.1 |
| | | | 1/7/2010 | ND<0.1 | ND<0.1 |
| | | | 4/7/2010 | ND<0.1 | ND<0.1 |
| | | | 7/7/2010 | 0.02 J | 0.02 J |
| | | | 8/16/2011 | 0.02 J | 0.02 J |
| | | | 10/26/2011 | 0.03 J | 0.03 J |

**Non-Parametric Prediction Interval**
**Inter-Well Comparison**
**Parameter: Iron, Dissolved**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

Number of comparisons = 7
Future Samples (k) – 1
Recent Dates = 1
Background Measurements (n) = 116
**Maximum Background Value = 18.4**
Confidence Level = 99%
False Positive Rate = 1%

| Location | Date | Count | Mean | Significant |
|---|---|---|---|---|
| B-30A | 4/4/2012 | 1 | 21.23 | TRUE |
| B-32 | 4/4/2012 | 1 | 0.25 | FALSE |
| B-31 | 4/4/2012 | 1 | 0.25 | FALSE |
| DM-1 | 4/4/2012 | 1 | 2.19 | FALSE |
| DM-7 | 4/4/2012 | 1 | 0.06 | FALSE |
| DM-6 | 4/4/2012 | 1 | 0.25 | FALSE |
| DM-5 | 4/4/2012 | 1 | 0.25 | FALSE |

**Shapiro-Francia Test of Normality (Continued)**
**Parameter: Iron, Dissolved**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Natural Logarithm Transformation**
**Non-Detects Replaced with Quantitation Limit**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | -1.38629 | 0.163659 | 54.4516 | 96.4244 |
| 67 | -1.38629 | 0.184017 | 54.4854 | 96.1693 |
| 68 | -1.38629 | 0.207012 | 54.5283 | 95.8824 |
| 69 | -1.38629 | 0.227545 | 54.5801 | 95.5669 |
| 70 | -1.38629 | 0.250759 | 54.643 | 95.2193 |
| 71 | -1.38629 | 0.271509 | 54.7167 | 94.8429 |
| 72 | -1.38629 | 0.294992 | 54.8037 | 94.434 |
| 73 | -0.597837 | 0.316004 | 54.9036 | 94.245 |
| 74 | -0.579818 | 0.33981 | 55.019 | 94.048 |
| 75 | -0.371064 | 0.363809 | 55.1514 | 93.913 |
| 76 | -0.34249 | 0.385321 | 55.2999 | 93.781 |
| 77 | 0.494696 | 0.409735 | 55.4677 | 93.9837 |
| 78 | 0.559616 | 0.431644 | 55.6541 | 94.2253 |
| 79 | 0.828552 | 0.456542 | 55.8625 | 94.6036 |
| 80 | 1.08856 | 0.478914 | 56.0918 | 95.1249 |
| 81 | 1.09527 | 0.504372 | 56.3462 | 95.6773 |
| 82 | 1.12817 | 0.52728 | 56.6243 | 96.2722 |
| 83 | 1.24415 | 0.553384 | 56.9305 | 96.9607 |
| 84 | 1.27536 | 0.576911 | 57.2633 | 97.6964 |
| 85 | 1.35584 | 0.603765 | 57.6278 | 98.515 |
| 86 | 1.38629 | 0.631062 | 58.0261 | 99.3899 |
| 87 | 1.45629 | 0.655726 | 58.4561 | 100.345 |
| 88 | 1.4816 | 0.68396 | 58.9239 | 101.358 |
| 89 | 1.58924 | 0.709522 | 59.4273 | 102.486 |
| 90 | 1.59737 | 0.738846 | 59.9732 | 103.666 |
| 91 | 1.6901 | 0.765456 | 60.5591 | 104.96 |
| 92 | 1.77834 | 0.796056 | 61.1928 | 106.375 |
| 93 | 1.78842 | 0.823893 | 61.8716 | 107.849 |
| 94 | 1.79509 | 0.855996 | 62.6043 | 109.385 |
| 95 | 1.96431 | 0.885291 | 63.3881 | 111.124 |
| 96 | 2.04511 | 0.919183 | 64.233 | 113.004 |
| 97 | 2.13417 | 0.954165 | 65.1434 | 115.041 |
| 98 | 2.20937 | 0.986272 | 66.1161 | 117.22 |
| 99 | 2.23001 | 1.02365 | 67.164 | 119.502 |
| 100 | 2.25863 | 1.05812 | 68.2836 | 121.892 |
| 101 | 2.26384 | 1.09847 | 69.4903 | 124.379 |
| 102 | 2.31944 | 1.1359 | 70.7805 | 127.014 |
| 103 | 2.32825 | 1.18 | 72.1729 | 129.761 |
| 104 | 2.3302 | 1.22123 | 73.6643 | 132.607 |
| 105 | 2.33892 | 1.27024 | 75.2778 | 135.578 |
| 106 | 2.3988 | 1.31652 | 77.011 | 138.736 |
| 107 | 2.45445 | 1.3722 | 78.894 | 142.104 |
| 108 | 2.56879 | 1.4325 | 80.9461 | 145.784 |
| 109 | 2.61667 | 1.49085 | 83.1687 | 149.685 |
| 110 | 2.65886 | 1.56322 | 85.6124 | 153.841 |
| 111 | 2.71734 | 1.63524 | 88.2864 | 158.285 |
| 112 | 2.73046 | 1.72793 | 91.2721 | 163.003 |
| 113 | 2.80215 | 1.82501 | 94.6027 | 168.116 |
| 114 | 2.81421 | 1.95996 | 98.4442 | 173.632 |
| 115 | 2.83615 | 2.12007 | 102.939 | 179.645 |
| 116 | 2.91235 | 2.40892 | 108.742 | 186.661 |

Data Set Standard Deviation = 1.81321
Numerator = 34842.2
Denominator = 41114.3
W Statistic = 0.847449 = 34842.2 / 41114.3

5% Critical value of 0.976 exceeds 0.847449
Evidence of non-normality at 95% level of significance

## Shapiro-Francia Test of Normality

**Parameter: Iron, Dissolved**

Background Locations

Normality Test of Parameter Concentrations

Natural Logarithm Transformation

Non-Detects Replaced with Quantitation Limit

Total Number of Measurements = 116

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | -2.99573 | -2.40892 | 5.80292 | 7.21649 |
| 2 | -2.81341 | -2.12007 | 10.2976 | 13.1811 |
| 3 | -2.81341 | -1.95996 | 14.1391 | 18.6953 |
| 4 | -2.81341 | -1.82501 | 17.4697 | 23.8298 |
| 5 | -2.81341 | -1.72793 | 20.4554 | 28.6912 |
| 6 | -2.81341 | -1.63524 | 23.1294 | 33.2917 |
| 7 | -2.81341 | -1.56322 | 25.5731 | 37.6897 |
| 8 | -2.81341 | -1.49085 | 27.7957 | 41.8841 |
| 9 | -2.65926 | -1.4325 | 29.8478 | 45.6935 |
| 10 | -2.65926 | -1.3722 | 31.7308 | 49.3426 |
| 11 | -2.65926 | -1.31652 | 33.464 | 52.8435 |
| 12 | -2.52573 | -1.27024 | 35.0775 | 56.0518 |
| 13 | -2.52573 | -1.22123 | 36.5689 | 59.1363 |
| 14 | -2.52573 | -1.18 | 37.9613 | 62.1167 |
| 15 | -2.30259 | -1.1359 | 39.2515 | 64.7322 |
| 16 | -2.20727 | -1.09847 | 40.4582 | 67.1568 |
| 17 | -2.20727 | -1.05812 | 41.5778 | 69.4923 |
| 18 | -1.96611 | -1.02365 | 42.6257 | 71.505 |
| 19 | -1.60944 | -0.986272 | 43.5984 | 73.0923 |
| 20 | -1.42712 | -0.954165 | 44.5088 | 74.454 |
| 21 | -1.38629 | -0.919183 | 45.3537 | 75.7283 |
| 22 | -1.38629 | -0.885291 | 46.1375 | 76.9555 |
| 23 | -1.38629 | -0.855996 | 46.8702 | 78.1422 |
| 24 | -1.38629 | -0.823893 | 47.549 | 79.2844 |
| 25 | -1.38629 | -0.796056 | 48.1827 | 80.3879 |
| 26 | -1.38629 | -0.765456 | 48.7686 | 81.4491 |
| 27 | -1.38629 | -0.738846 | 49.3145 | 82.4733 |
| 28 | -1.38629 | -0.709522 | 49.8179 | 83.4569 |
| 29 | -1.38629 | -0.68396 | 50.2857 | 84.4051 |
| 30 | -1.38629 | -0.655726 | 50.7157 | 85.3141 |
| 31 | -1.38629 | -0.631062 | 51.114 | 86.189 |
| 32 | -1.38629 | -0.603765 | 51.4785 | 87.026 |
| 33 | -1.38629 | -0.576911 | 51.8113 | 87.8257 |
| 34 | -1.38629 | -0.553384 | 52.1175 | 88.5929 |
| 35 | -1.38629 | -0.52728 | 52.3956 | 89.3239 |
| 36 | -1.38629 | -0.504372 | 52.65 | 90.0231 |
| 37 | -1.38629 | -0.478914 | 52.8793 | 90.687 |
| 38 | -1.38629 | -0.456542 | 53.0877 | 91.3199 |
| 39 | -1.38629 | -0.431644 | 53.2741 | 91.9183 |
| 40 | -1.38629 | -0.409735 | 53.4419 | 92.4863 |
| 41 | -1.38629 | -0.385321 | 53.5904 | 93.0205 |
| 42 | -1.38629 | -0.363809 | 53.7228 | 93.5248 |
| 43 | -1.38629 | -0.33981 | 53.8382 | 93.9959 |
| 44 | -1.38629 | -0.316004 | 53.9381 | 94.434 |
| 45 | -1.38629 | -0.294992 | 54.0251 | 94.8429 |
| 46 | -1.38629 | -0.271509 | 54.0988 | 95.2193 |
| 47 | -1.38629 | -0.250759 | 54.1617 | 95.5669 |
| 48 | -1.38629 | -0.227545 | 54.2135 | 95.8824 |
| 49 | -1.38629 | -0.207012 | 54.2564 | 96.1693 |
| 50 | -1.38629 | -0.184017 | 54.2902 | 96.4244 |
| 51 | -1.38629 | -0.163659 | 54.317 | 96.6513 |
| 52 | -1.38629 | -0.140835 | 54.3368 | 96.8466 |
| 53 | -1.38629 | -0.12061 | 54.3514 | 97.0138 |
| 54 | -1.38629 | -0.0979139 | 54.361 | 97.1495 |
| 55 | -1.38629 | -0.0752698 | 54.3666 | 97.2538 |
| 56 | -1.38629 | -0.0551734 | 54.3697 | 97.3303 |
| 57 | -1.38629 | -0.0325917 | 54.3707 | 97.3755 |
| 58 | -1.38629 | -0.0125328 | 54.3709 | 97.3929 |
| 59 | -1.38629 | 0.0125328 | 54.3711 | 97.3755 |
| 60 | -1.38629 | 0.0325917 | 54.3721 | 97.3303 |
| 61 | -1.38629 | 0.0551734 | 54.3752 | 97.2538 |
| 62 | -1.38629 | 0.0752698 | 54.3808 | 97.1495 |
| 63 | -1.38629 | 0.0979139 | 54.3904 | 97.0138 |
| 64 | -1.38629 | 0.12061 | 54.405 | 96.8466 |
| 65 | -1.38629 | 0.140835 | 54.4248 | 96.6513 |

## Shapiro-Francia Test of Normality (Continued)

**Parameter: Iron, Dissolved**

**Background Locations**

**Normality Test of Parameter Concentrations**

**Original Data (Not Transformed)**

**Non-Detects Replaced with Quantitation Limit**

**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 0.25 | 0.163659 | 54.4516 | -6.32445 |
| 67 | 0.25 | 0.184017 | 54.4854 | -6.27844 |
| 68 | 0.25 | 0.207012 | 54.5283 | -6.22669 |
| 69 | 0.25 | 0.227545 | 54.5801 | -6.1698 |
| 70 | 0.25 | 0.250759 | 54.643 | -6.10711 |
| 71 | 0.25 | 0.271509 | 54.7167 | -6.03923 |
| 72 | 0.25 | 0.294992 | 54.8037 | -5.96549 |
| 73 | 0.55 | 0.316004 | 54.9036 | -5.79168 |
| 74 | 0.56 | 0.33981 | 55.019 | -5.60139 |
| 75 | 0.69 | 0.363809 | 55.1514 | -5.35036 |
| 76 | 0.71 | 0.385321 | 55.2999 | -5.07678 |
| 77 | 1.64 | 0.409735 | 55.4677 | -4.40482 |
| 78 | 1.75 | 0.431644 | 55.6541 | -3.64944 |
| 79 | 2.29 | 0.456542 | 55.8625 | -2.60396 |
| 80 | 2.97 | 0.478914 | 56.0918 | -1.18159 |
| 81 | 2.99 | 0.504372 | 56.3462 | 0.326486 |
| 82 | 3.09 | 0.52728 | 56.6243 | 1.95578 |
| 83 | 3.47 | 0.553384 | 56.9305 | 3.87602 |
| 84 | 3.58 | 0.576911 | 57.2633 | 5.94136 |
| 85 | 3.88 | 0.603765 | 57.6278 | 8.28397 |
| 86 | 4 | 0.631062 | 58.0261 | 10.8082 |
| 87 | 4.29 | 0.655726 | 58.4561 | 13.6213 |
| 88 | 4.4 | 0.68396 | 58.9239 | 16.6307 |
| 89 | 4.9 | 0.709522 | 59.4273 | 20.1074 |
| 90 | 4.94 | 0.738846 | 59.9732 | 23.7573 |
| 91 | 5.42 | 0.765456 | 60.5591 | 27.906 |
| 92 | 5.92 | 0.796056 | 61.1928 | 32.6187 |
| 93 | 5.98 | 0.823893 | 61.8716 | 37.5456 |
| 94 | 6.02 | 0.855996 | 62.6043 | 42.6987 |
| 95 | 7.13 | 0.885291 | 63.3881 | 49.0108 |
| 96 | 7.73 | 0.919183 | 64.233 | 56.1161 |
| 97 | 8.45 | 0.954165 | 65.1434 | 64.1788 |
| 98 | 9.11 | 0.986272 | 66.1161 | 73.1637 |
| 99 | 9.3 | 1.02365 | 67.164 | 82.6837 |
| 100 | 9.57 | 1.05812 | 68.2836 | 92.8099 |
| 101 | 9.62 | 1.09847 | 69.4903 | 103.377 |
| 102 | 10.17 | 1.1359 | 70.7805 | 114.929 |
| 103 | 10.26 | 1.18 | 72.1729 | 127.036 |
| 104 | 10.28 | 1.22123 | 73.6643 | 139.59 |
| 105 | 10.37 | 1.27024 | 75.2778 | 152.763 |
| 106 | 11.01 | 1.31652 | 77.011 | 167.258 |
| 107 | 11.64 | 1.3722 | 78.894 | 183.23 |
| 108 | 13.05 | 1.4325 | 80.9461 | 201.924 |
| 109 | 13.69 | 1.49085 | 83.1687 | 222.334 |
| 110 | 14.28 | 1.56322 | 85.6124 | 244.657 |
| 111 | 15.14 | 1.63524 | 88.2864 | 269.414 |
| 112 | 15.34 | 1.72793 | 91.2721 | 295.921 |
| 113 | 16.48 | 1.82501 | 94.6027 | 325.997 |
| 114 | 16.68 | 1.95996 | 98.4442 | 358.689 |
| 115 | 17.05 | 2.12007 | 102.939 | 394.836 |
| 116 | 18.4 | 2.40892 | 108.742 | 439.16 |

Data Set Standard Deviation = 4.8125

Numerator = 192862

Denominator = 289625

W Statistic = 0.665902 = 192862 / 289625

5% Critical value of 0.976 exceeds 0.665902

Evidence of non-normality at 95% level of significance

**Shapiro-Francia Test of Normality**
**Parameter: Iron, Dissolved**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**
**Total Number of Measurements = 116**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 0.05 | -2.40892 | 5.80292 | -0.120446 |
| 2 | 0.06 | -2.12007 | 10.2976 | -0.24765 |
| 3 | 0.06 | -1.95996 | 14.1391 | -0.365248 |
| 4 | 0.06 | -1.82501 | 17.4697 | -0.474748 |
| 5 | 0.06 | -1.72793 | 20.4554 | -0.578424 |
| 6 | 0.06 | -1.63524 | 23.1294 | -0.676538 |
| 7 | 0.06 | -1.56322 | 25.5731 | -0.770332 |
| 8 | 0.06 | -1.49085 | 27.7957 | -0.859783 |
| 9 | 0.07 | -1.4325 | 29.8478 | -0.960058 |
| 10 | 0.07 | -1.3722 | 31.7308 | -1.05611 |
| 11 | 0.07 | -1.31652 | 33.464 | -1.14827 |
| 12 | 0.08 | -1.27024 | 35.0775 | -1.24989 |
| 13 | 0.08 | -1.22123 | 36.5689 | -1.34759 |
| 14 | 0.08 | -1.18 | 37.9613 | -1.44199 |
| 15 | 0.1 | -1.1359 | 39.2515 | -1.55558 |
| 16 | 0.11 | -1.09847 | 40.4582 | -1.67641 |
| 17 | 0.11 | -1.05812 | 41.5778 | -1.7928 |
| 18 | 0.14 | -1.02365 | 42.6257 | -1.93611 |
| 19 | 0.2 | -0.986272 | 43.5984 | -2.13337 |
| 20 | 0.24 | -0.954165 | 44.5088 | -2.36237 |
| 21 | 0.25 | -0.919183 | 45.3537 | -2.59216 |
| 22 | 0.25 | -0.885291 | 46.1375 | -2.81348 |
| 23 | 0.25 | -0.855996 | 46.8702 | -3.02748 |
| 24 | 0.25 | -0.823893 | 47.549 | -3.23346 |
| 25 | 0.25 | -0.796056 | 48.1827 | -3.43247 |
| 26 | 0.25 | -0.765456 | 48.7686 | -3.62383 |
| 27 | 0.25 | -0.738846 | 49.3145 | -3.80855 |
| 28 | 0.25 | -0.709522 | 49.8179 | -3.98593 |
| 29 | 0.25 | -0.68396 | 50.2857 | -4.15692 |
| 30 | 0.25 | -0.655726 | 50.7157 | -4.32085 |
| 31 | 0.25 | -0.631062 | 51.114 | -4.47861 |
| 32 | 0.25 | -0.603765 | 51.4785 | -4.62955 |
| 33 | 0.25 | -0.576911 | 51.8113 | -4.77378 |
| 34 | 0.25 | -0.553384 | 52.1175 | -4.91213 |
| 35 | 0.25 | -0.52728 | 52.3956 | -5.04395 |
| 36 | 0.25 | -0.504372 | 52.65 | -5.17004 |
| 37 | 0.25 | -0.478914 | 52.8793 | -5.28977 |
| 38 | 0.25 | -0.456542 | 53.0877 | -5.40391 |
| 39 | 0.25 | -0.431644 | 53.2741 | -5.51182 |
| 40 | 0.25 | -0.409735 | 53.4419 | -5.61425 |
| 41 | 0.25 | -0.385321 | 53.5904 | -5.71058 |
| 42 | 0.25 | -0.363809 | 53.7228 | -5.80153 |
| 43 | 0.25 | -0.33981 | 53.8382 | -5.88649 |
| 44 | 0.25 | -0.316004 | 53.9381 | -5.96549 |
| 45 | 0.25 | -0.294992 | 54.0251 | -6.03923 |
| 46 | 0.25 | -0.271509 | 54.0988 | -6.10711 |
| 47 | 0.25 | -0.250759 | 54.1617 | -6.1698 |
| 48 | 0.25 | -0.227545 | 54.2135 | -6.22669 |
| 49 | 0.25 | -0.207012 | 54.2564 | -6.27844 |
| 50 | 0.25 | -0.184017 | 54.2902 | -6.32445 |
| 51 | 0.25 | -0.163659 | 54.317 | -6.36536 |
| 52 | 0.25 | -0.140835 | 54.3368 | -6.40057 |
| 53 | 0.25 | -0.12061 | 54.3514 | -6.43072 |
| 54 | 0.25 | -0.0979139 | 54.361 | -6.4552 |
| 55 | 0.25 | -0.0752698 | 54.3666 | -6.47402 |
| 56 | 0.25 | 0.0551734 | 54.3697 | -6.48781 |
| 57 | 0.25 | -0.0325917 | 54.3707 | -6.49596 |
| 58 | 0.25 | -0.0125328 | 54.3709 | -6.49909 |
| 59 | 0.25 | 0.0125328 | 54.3711 | -6.49596 |
| 60 | 0.25 | 0.0325917 | 54.3721 | -6.48781 |
| 61 | 0.25 | 0.0551734 | 54.3752 | -6.47402 |
| 62 | 0.25 | 0.0752698 | 54.3808 | -6.4552 |
| 63 | 0.25 | 0.0979139 | 54.3904 | -6.43072 |
| 64 | 0.25 | 0.12061 | 54.405 | -6.40057 |
| 65 | 0.25 | 0.140835 | 54.4248 | -6.36536 |

**Rosner's Test for Outliers (Continued)**
**Parameter: Iron, Dissolved**
**Background Locations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

--------------------------------------------

Iteration i = 3
Mean of 113 measurements = 2.66796
Std Dev = 4.25685
x(i+1) = 16.48 from measurement 1/4/2007 from location B-50
Rosner Statistic R = |16.48 - 2.66796|/4.25685 = 3.24466
Lambda(116, 4, 0.05) = 3.4148
3.24466 < 3.4148 -- No outliers detected for i = 3

--------------------------------------------

Iteration i = 2
Mean of 114 measurements = 2.79088
Std Dev = 4.43652
x(i+1) = 16.68 from measurement 10/6/2004 from location B-50
Rosner Statistic R = |16.68 - 2.79088|/4.43652 = 3.13064
Lambda(116, 3, 0.05) = 3.4216
3.13064 < 3.4216 -- No outliers detected for i = 2

--------------------------------------------

Iteration i = 1
Mean of 115 measurements = 2.91487
Std Dev = 4.61281
x(i+1) = 17.05 from measurement 10/2/2003 from location B-50
Rosner Statistic R = |17.05 - 2.91487|/4.61281 = 3.06432
Lambda(116, 2, 0.05) = 3.4216
3.06432 < 3.4216 -- No outliers detected for i = 1

--------------------------------------------

Iteration i = 0
Mean of 116 measurements = 3.04836
Std Dev = 4.8125
x(i+1) = 18.4 from measurement 4/7/2010 from location B-50
Rosner Statistic R = |18.4 - 3.04836|/4.8125 = 3.18995
Lambda(116, 1, 0.05) = 3.4248
3.18995 < 3.4248 -- No outliers detected for i = 0

**NO OUTLIERS DETECTED**

**Rosner's Test for Outliers**
**Parameter: Iron, Dissolved**
**Background Locations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

Data set mean = 3.04836

10 most extreme of 116 measurements
by order of magnitude difference from the mean

| | | | | |
|---|---|---|---|---|
| 1 | 4/7/2010 | B-50 | 18.4 | 15.3516 |
| 2 | 10/2/2003 | B-50 | 17.05 | 14.0016 |
| 3 | 10/6/2004 | B-50 | 16.68 | 13.6316 |
| 4 | 1/4/2007 | B-50 | 16.48 | 13.4316 |
| 5 | 1/7/2004 | B-50 | 15.34 | 12.2916 |
| 6 | 1/5/2006 | B-50 | 15.14 | 12.0916 |
| 7 | 4/4/2007 | B-50 | 14.28 | 11.2316 |
| 8 | 1/7/2010 | B-50 | 13.69 | 10.6416 |
| 9 | 1/6/2005 | B-50 | 13.05 | 10.0016 |
| 10 | 7/13/2004 | B-50 | 11.64 | 8.59164 |

---

Iteration i = 9
Mean of 107 measurements = 1.99533
Std Dev = 3.23615
x(i+1) = 11.64 from measurement 7/13/2004 from location B-50
Rosner Statistic R = |11.64 - 1.99533|/3.23615 = 2.9803
Lambda(116, 10, 0.05) = 3.398
2.9803 < 3.398 -- No outliers detected for i = 9

---

Iteration i = 8
Mean of 108 measurements = 2.09769
Std Dev = 3.39209
x(i+1) = 13.05 from measurement 1/6/2005 from location B-50
Rosner Statistic R = |13.05 - 2.09769|/3.39209 = 3.22878
Lambda(116, 9, 0.05) = 3.40136
3.22878 < 3.40136 -- No outliers detected for i = 8

---

Iteration i = 7
Mean of 109 measurements = 2.20404
Std Dev = 3.55424
x(i+1) = 13.69 from measurement 1/7/2010 from location B-50
Rosner Statistic R = |13.69 - 2.20404|/3.55424 = 3.23162
Lambda(116, 8, 0.05) = 3.40472
3.23162 < 3.40472 -- No outliers detected for i = 7

---

Iteration i = 6
Mean of 110 measurements = 2.31382
Std Dev = 3.72054
x(i+1) = 14.28 from measurement 4/4/2007 from location B-50
Rosner Statistic R = |14.28 - 2.31382|/3.72054 = 3.21625
Lambda(116, 7, 0.05) = 3.40808
3.21625 < 3.40808 -- No outliers detected for i = 6

---

Iteration i = 5
Mean of 111 measurements = 2.42937
Std Dev = 3.89855
x(i+1) = 15.14 from measurement 1/5/2006 from location B-50
Rosner Statistic R = |15.14 - 2.42937|/3.89855 = 3.26035
Lambda(116, 6, 0.05) = 3.41144
3.26035 < 3.41144 -- No outliers detected for i = 5

---

Iteration i = 4
Mean of 112 measurements = 2.54464
Std Dev = 4.06817
x(i+1) = 15.34 from measurement 1/7/2004 from location B-50
Rosner Statistic R = |15.34 - 2.54464|/4.06817 = 3.14524
Lambda(116, 5, 0.05) = 3.4148
3.14524 < 3.4148 -- No outliers detected for i = 4

## Concentrations (mg/L) - Continued

**Parameter: Iron, Dissolved**

Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 44.8276%
Total Background Measurements: 116
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| | | | 7/23/2008 | 0.06 J | 0.06 J |
| | | | 10/22/2008 | 0.06 J | 0.06 J |
| | | | 1/13/2009 | 0.08 J | 0.08 J |
| | | | 4/8/2009 | ND<0.25 | ND<0.25 |
| | | | 7/15/2009 | ND<0.25 | ND<0.25 |
| | | | 1/7/2010 | 0.07 J | 0.07 J |
| | | | 4/7/2010 | ND<0.25 | ND<0.25 |
| | | | 7/7/2010 | 0.06 J | 0.06 J |
| | | | 8/16/2011 | ND<0.25 | ND<0.25 |
| | | | 10/26/2011 | 0.06 J | 0.06 J |
| B-50 | 42 | 0 (0%) | 11/15/2001 | 0.55 | 0.55 |
| | | | 1/16/2002 | 9.57 | 9.57 |
| | | | 4/3/2002 | 11.01 | 11.01 |
| | | | 7/2/2002 | 0.69 | 0.69 |
| | | | 10/2/2002 | 1.75 | 1.75 |
| | | | 1/8/2003 | 9.62 | 9.62 |
| | | | 4/2/2003 | 5.42 | 5.42 |
| | | | 7/23/2003 | 8.45 | 8.45 |
| | | | 10/2/2003 | 17.05 | 17.05 |
| | | | 1/7/2004 | 15.34 | 15.34 |
| | | | 4/7/2004 | 10.28 | 10.28 |
| | | | 7/13/2004 | 11.64 | 11.64 |
| | | | 10/6/2004 | 16.68 | 16.68 |
| | | | 1/6/2005 | 13.05 | 13.05 |
| | | | 4/6/2005 | 9.3 | 9.3 |
| | | | 7/27/2005 | 3.09 | 3.09 |
| | | | 10/13/2005 | 2.99 | 2.99 |
| | | | 1/5/2006 | 15.14 | 15.14 |
| | | | 4/6/2006 | 10.17 | 10.17 |
| | | | 7/25/2006 | 4.94 | 4.94 |
| | | | 10/11/2006 | 5.92 | 5.92 |
| | | | 1/4/2007 | 16.48 | 16.48 |
| | | | 4/4/2007 | 14.28 | 14.28 |
| | | | 7/12/2007 | 7.73 | 7.73 |
| | | | 10/10/2007 | 4.9 | 4.9 |
| | | | 1/16/2008 | 3.47 | 3.47 |
| | | | 4/3/2008 | 10.37 | 10.37 |
| | | | 7/23/2008 | 4.29 | 4.29 |
| | | | 10/22/2008 | 3.88 | 3.88 |
| | | | 1/13/2009 | 6.02 | 6.02 |
| | | | 4/8/2009 | 10.26 | 10.26 |
| | | | 7/15/2009 | 3.58 | 3.58 |
| | | | 10/8/2009 | 2.29 | 2.29 |
| | | | 1/7/2010 | 13.69 | 13.69 |
| | | | 4/7/2010 | 18.4 | 18.4 |
| | | | 7/7/2010 | 9.11 | 9.11 |
| | | | 12/8/2010 | 5.98 | 5.98 |
| | | | 2/3/2011 | 1.64 | 1.64 |
| | | | 4/13/2011 | 4 | 4 |
| | | | 8/16/2011 | 7.13 | 7.13 |
| | | | 10/26/2011 | 4.4 | 4.4 |
| | | | 1/18/2012 | 2.97 | 2.97 |

## Concentrations (mg/L)

**Parameter: Iron, Dissolved**
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 44.8276%
Total Background Measurements: 116
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-52 | 42 | 30 (71.4286%) | 11/15/2001 | 0.71 | 0.71 |
| | | | 1/16/2002 | 0.56 | 0.56 |
| | | | 4/3/2002 | 0.24 J | 0.24 J |
| | | | 7/2/2002 | 0.2 J | 0.2 J |
| | | | 10/2/2002 | ND<0.25 | ND<0.25 |
| | | | 1/8/2003 | ND<0.25 | ND<0.25 |
| | | | 4/2/2003 | ND<0.25 | ND<0.25 |
| | | | 7/23/2003 | ND<0.25 | ND<0.25 |
| | | | 10/2/2003 | ND<0.25 | ND<0.25 |
| | | | 1/7/2004 | ND<0.25 | ND<0.25 |
| | | | 4/7/2004 | ND<0.25 | ND<0.25 |
| | | | 7/13/2004 | ND<0.25 | ND<0.25 |
| | | | 10/6/2004 | 0.07 J | 0.07 J |
| | | | 1/6/2005 | ND<0.25 | ND<0.25 |
| | | | 4/6/2005 | ND<0.25 | ND<0.25 |
| | | | 7/27/2005 | ND<0.25 | ND<0.25 |
| | | | 10/13/2005 | ND<0.25 | ND<0.25 |
| | | | 1/5/2006 | ND<0.25 | ND<0.25 |
| | | | 4/6/2006 | ND<0.25 | ND<0.25 |
| | | | 7/25/2006 | ND<0.25 | ND<0.25 |
| | | | 10/11/2006 | 0.08 J | 0.08 J |
| | | | 1/4/2007 | ND<0.25 | ND<0.25 |
| | | | 4/4/2007 | ND<0.25 | ND<0.25 |
| | | | 7/12/2007 | ND<0.25 | ND<0.25 |
| | | | 10/10/2007 | ND<0.25 | ND<0.25 |
| | | | 1/16/2008 | ND<0.25 | ND<0.25 |
| | | | 4/3/2008 | 0.07 J | 0.07 J |
| | | | 7/23/2008 | ND<0.25 | ND<0.25 |
| | | | 10/22/2008 | 0.1 J | 0.1 J |
| | | | 1/13/2009 | 0.06 J | 0.06 J |
| | | | 4/8/2009 | 0.08 J | 0.08 J |
| | | | 7/15/2009 | 0.11 J | 0.11 J |
| | | | 10/8/2009 | ND<0.25 | ND<0.25 |
| | | | 1/7/2010 | 0.11 J | 0.11 J |
| | | | 4/7/2010 | ND<0.25 | ND<0.25 |
| | | | 7/7/2010 | ND<0.25 | ND<0.25 |
| | | | 12/8/2010 | ND<0.25 | ND<0.25 |
| | | | 2/3/2011 | ND<0.25 | ND<0.25 |
| | | | 4/13/2011 | ND<0.25 | ND<0.25 |
| | | | 8/16/2011 | ND<0.25 | ND<0.25 |
| | | | 10/26/2011 | ND<0.25 | ND<0.25 |
| | | | 1/18/2012 | ND<0.25 | ND<0.25 |
| B-51 | 32 | 22 (68.75%) | 11/15/2001 | 0.14 J | 0.14 J |
| | | | 10/2/2002 | ND<0.25 | ND<0.25 |
| | | | 1/8/2003 | ND<0.25 | ND<0.25 |
| | | | 4/2/2003 | ND<0.25 | ND<0.25 |
| | | | 7/23/2003 | ND<0.25 | ND<0.25 |
| | | | 10/2/2003 | ND<0.25 | ND<0.25 |
| | | | 1/7/2004 | ND<0.25 | ND<0.25 |
| | | | 4/7/2004 | ND<0.25 | ND<0.25 |
| | | | 7/13/2004 | ND<0.25 | ND<0.25 |
| | | | 10/6/2004 | 0.06 J | 0.06 J |
| | | | 1/6/2005 | ND<0.25 | ND<0.25 |
| | | | 4/6/2005 | 0.06 J | 0.06 J |
| | | | 7/27/2005 | ND<0.25 | ND<0.25 |
| | | | 10/13/2005 | ND<0.25 | ND<0.25 |
| | | | 1/5/2006 | ND<0.25 | ND<0.25 |
| | | | 4/6/2006 | ND<0.25 | ND<0.25 |
| | | | 7/25/2006 | ND<0.25 | ND<0.25 |
| | | | 10/11/2006 | 0.05 J | 0.05 J |
| | | | 1/4/2007 | ND<0.25 | ND<0.25 |
| | | | 4/4/2007 | ND<0.25 | ND<0.25 |
| | | | 7/12/2007 | ND<0.25 | ND<0.25 |
| | | | 10/10/2007 | ND<0.25 | ND<0.25 |

**Non-Parametric Prediction Interval**
**Inter-Well Comparison**
**Parameter: Chromium (hexavalent)**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 103
**Maximum Background Value = LOQ = 0.05**
Confidence Level = 99%
False Positive Rate = 1%

| Location | Date | Count | Mean | Significant |
|---|---|---|---|---|
| B-30A | 4/4/2012 | 1 | 0.005 | FALSE |
| B-32 | 4/4/2012 | 1 | 0.005 | FALSE |
| B-31 | 4/4/2012 | 1 | 0.005 | FALSE |
| DM-1 | 4/4/2012 | 1 | 0.006 | FALSE |
| DM-7 | 4/4/2012 | 1 | 0.005 | FALSE |
| DM-6 | 4/4/2012 | 1 | 0.005 | FALSE |
| DM-5 | 4/4/2012 | 1 | 0.005 | FALSE |

**Rosner's Test for Outliers (Continued)**
**Parameter: Chromium (hexavalent)**
**Background Locations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

---

Iteration i = 3
Mean of 100 measurements = 0.04195
Std Dev = 0.0158097
x(i+1) = 0.005 from measurement 4/13/2011 from location B-50
Rosner Statistic R = |0.005 - 0.04195|/0.0158097 = 2.33717
Lambda(103, 4, 0.05) = 3.3784
2.33717 < 3.3784 -- No outliers detected for i = 3

---

Iteration i = 2
Mean of 101 measurements = 0.0415842
Std Dev = 0.0161544
x(i+1) = 0.005 from measurement 8/16/2011 from location B-50
Rosner Statistic R = |0.005 - 0.0415842|/0.0161544 = 2.26465
Lambda(103, 3, 0.05) = 3.3878
2.26465 < 3.3878 -- No outliers detected for i = 2

---

Iteration i = 1
Mean of 102 measurements = 0.0412255
Std Dev = 0.0164774
x(i+1) = 0.005 from measurement 10/26/2011 from location B-50
Rosner Statistic R = |0.005 - 0.0412255|/0.0164774 = 2.1985
Lambda(103, 2, 0.05) = 3.3878
2.1985 < 3.3878 -- No outliers detected for i = 1

---

Iteration i = 0
Mean of 103 measurements = 0.0408738
Std Dev = 0.0167804
x(i+1) = 0.005 from measurement 1/18/2012 from location B-50
Rosner Statistic R = |0.005 - 0.0408738|/0.0167804 = 2.13784
Lambda(103, 1, 0.05) = 3.3884
2.13784 < 3.3884 -- No outliers detected for i = 0

**NO OUTLIERS DETECTED**

**Rosner's Test for Outliers**
**Parameter: Chromium (hexavalent)**
**Background Locations**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**

Data set mean = 0.0408738

10 most extreme of 103 measurements
by order of magnitude difference from the mean

| | | | | |
|---|---|---|---|---|
| 1 | 1/18/2012 | B-50 | ND<0.005 | -0.0358738 |
| 2 | 10/26/2011 | B-50 | ND<0.005 | -0.0358738 |
| 3 | 8/16/2011 | B-50 | ND<0.005 | -0.0358738 |
| 4 | 4/13/2011 | B-50 | ND<0.005 | -0.0358738 |
| 5 | 8/16/2011 | B-51 | ND<0.005 | -0.0358738 |
| 6 | 12/8/2010 | B-50 | ND<0.005 | -0.0358738 |
| 7 | 10/26/2011 | B-52 | ND<0.005 | -0.0358738 |
| 8 | 10/26/2011 | B-51 | ND<0.005 | -0.0358738 |
| 9 | 4/13/2011 | B-52 | ND<0.005 | -0.0358738 |
| 10 | 1/18/2012 | B-52 | ND<0.005 | -0.0358738 |

-------------------------------------------

Iteration i = 9
Mean of 94 measurements = 0.0443085
Std Dev = 0.0131288
x(i+1) = 0.005 from measurement 1/18/2012 from location B-52
Rosner Statistic R = |0.005 - 0.0443085|/0.0131288 = 2.99406
Lambda(103, 10, 0.05) = 3.359
2.99406 < 3.359 -- No outliers detected for i = 9

-------------------------------------------

Iteration i = 8
Mean of 95 measurements = 0.0438947
Std Dev = 0.0136674
x(i+1) = 0.005 from measurement 4/13/2011 from location B-52
Rosner Statistic R = |0.005 - 0.0438947|/0.0136674 = 2.84581
Lambda(103, 9, 0.05) = 3.36288
2.84581 < 3.36288 -- No outliers detected for i = 8

-------------------------------------------

Iteration i = 7
Mean of 96 measurements = 0.0434896
Std Dev = 0.014163
x(i+1) = 0.005 from measurement 10/26/2011 from location B-51
Rosner Statistic R = |0.005 - 0.0434896|/0.014163 = 2.71762
Lambda(103, 8, 0.05) = 3.36676
2.71762 < 3.36676 -- No outliers detected for i = 7

-------------------------------------------

Iteration i = 6
Mean of 97 measurements = 0.0430928
Std Dev = 0.014621
x(i+1) = 0.005 from measurement 10/26/2011 from location B-52
Rosner Statistic R = |0.005 - 0.0430928|/0.014621 = 2.60535
Lambda(103, 7, 0.05) = 3.37064
2.60535 < 3.37064 -- No outliers detected for i = 6

-------------------------------------------

Iteration i = 5
Mean of 98 measurements = 0.0427041
Std Dev = 0.0150458
x(i+1) = 0.005 from measurement 12/8/2010 from location B-50
Rosner Statistic R = |0.005 - 0.0427041|/0.0150458 = 2.50596
Lambda(103, 6, 0.05) = 3.37452
2.50596 < 3.37452 -- No outliers detected for i = 5

-------------------------------------------

Iteration i = 4
Mean of 99 measurements = 0.0423232
Std Dev = 0.015441
x(i+1) = 0.005 from measurement 8/16/2011 from location B-51
Rosner Statistic R = |0.005 - 0.0423232|/0.015441 = 2.41715
Lambda(103, 5, 0.05) = 3.3784
2.41715 < 3.3784 -- No outliers detected for i = 4

**Concentrations (mg/L) - Continued**
**Parameter: Chromium (hexavalent)**
**Original Data (Not Transformed)**
**Non-Detects Replaced with Quantitation Limit**
**Percent Background Non-Detects: 100%**
**Total Background Measurements: 103**
**There are 3 background locations**

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-50 | 37 | 37 (100%) | 11/15/2001 | ND<0.01 | ND<0.01 |
| | | | 4/3/2002 | ND<0.01 | ND<0.01 |
| | | | 4/2/2003 | ND<0.05 | ND<0.05 |
| | | | 10/9/2003 | ND<0.05 | ND<0.05 |
| | | | 1/7/2004 | ND<0.05 | ND<0.05 |
| | | | 4/7/2004 | ND<0.05 | ND<0.05 |
| | | | 7/13/2004 | ND<0.05 | ND<0.05 |
| | | | 10/6/2004 | ND<0.05 | ND<0.05 |
| | | | 1/6/2005 | ND<0.05 | ND<0.05 |
| | | | 4/6/2005 | ND<0.05 | ND<0.05 |
| | | | 7/27/2005 | ND<0.05 | ND<0.05 |
| | | | 10/13/2005 | ND<0.05 | ND<0.05 |
| | | | 1/5/2006 | ND<0.05 | ND<0.05 |
| | | | 4/6/2006 | ND<0.05 | ND<0.05 |
| | | | 7/25/2006 | ND<0.05 | ND<0.05 |
| | | | 10/11/2006 | ND<0.05 | ND<0.05 |
| | | | 1/4/2007 | ND<0.05 | ND<0.05 |
| | | | 4/4/2007 | ND<0.05 | ND<0.05 |
| | | | 7/12/2007 | ND<0.05 | ND<0.05 |
| | | | 10/10/2007 | ND<0.05 | ND<0.05 |
| | | | 1/16/2008 | ND<0.05 | ND<0.05 |
| | | | 4/3/2008 | ND<0.05 | ND<0.05 |
| | | | 7/23/2008 | ND<0.05 | ND<0.05 |
| | | | 10/22/2008 | ND<0.05 | ND<0.05 |
| | | | 1/14/2009 | ND<0.05 | ND<0.05 |
| | | | 4/8/2009 | ND<0.05 | ND<0.05 |
| | | | 7/15/2009 | ND<0.05 | ND<0.05 |
| | | | 10/8/2009 | ND<0.05 | ND<0.05 |
| | | | 1/7/2010 | ND<0.05 | ND<0.05 |
| | | | 4/7/2010 | ND<0.025 | ND<0.025 |
| | | | 7/7/2010 | ND<0.025 | ND<0.025 |
| | | | 12/8/2010 | ND<0.005 | ND<0.005 |
| | | | 2/3/2011 | ND<0.025 | ND<0.025 |
| | | | 4/13/2011 | ND<0.005 | ND<0.005 |
| | | | 8/16/2011 | ND<0.005 | ND<0.005 |
| | | | 10/26/2011 | ND<0.005 | ND<0.005 |
| | | | 1/18/2012 | ND<0.005 | ND<0.005 |

Concentrations (mg/L)
Parameter: Chromium (hexavalent)
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 100%
Total Background Measurements: 103
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-52 | 37 | 37 (100%) | 11/15/2001 | ND<0.01 | ND<0.01 |
| | | | 4/3/2002 | ND<0.01 | ND<0.01 |
| | | | 4/2/2003 | ND<0.05 | ND<0.05 |
| | | | 10/9/2003 | ND<0.05 | ND<0.05 |
| | | | 1/7/2004 | ND<0.05 | ND<0.05 |
| | | | 4/7/2004 | ND<0.05 | ND<0.05 |
| | | | 7/13/2004 | ND<0.05 | ND<0.05 |
| | | | 10/6/2004 | ND<0.05 | ND<0.05 |
| | | | 1/6/2005 | ND<0.05 | ND<0.05 |
| | | | 4/6/2005 | ND<0.05 | ND<0.05 |
| | | | 7/27/2005 | ND<0.05 | ND<0.05 |
| | | | 10/13/2005 | ND<0.05 | ND<0.05 |
| | | | 1/5/2006 | ND<0.05 | ND<0.05 |
| | | | 4/6/2006 | ND<0.05 | ND<0.05 |
| | | | 7/25/2006 | ND<0.05 | ND<0.05 |
| | | | 10/11/2006 | ND<0.05 | ND<0.05 |
| | | | 1/4/2007 | ND<0.05 | ND<0.05 |
| | | | 4/4/2007 | ND<0.05 | ND<0.05 |
| | | | 7/12/2007 | ND<0.05 | ND<0.05 |
| | | | 10/10/2007 | ND<0.05 | ND<0.05 |
| | | | 1/16/2008 | ND<0.05 | ND<0.05 |
| | | | 4/3/2008 | ND<0.05 | ND<0.05 |
| | | | 7/23/2008 | ND<0.05 | ND<0.05 |
| | | | 10/22/2008 | ND<0.05 | ND<0.05 |
| | | | 1/14/2009 | ND<0.05 | ND<0.05 |
| | | | 4/8/2009 | ND<0.05 | ND<0.05 |
| | | | 7/15/2009 | ND<0.05 | ND<0.05 |
| | | | 10/8/2009 | ND<0.05 | ND<0.05 |
| | | | 1/7/2010 | ND<0.05 | ND<0.05 |
| | | | 4/7/2010 | ND<0.025 | ND<0.025 |
| | | | 7/7/2010 | ND<0.025 | ND<0.025 |
| | | | 12/8/2010 | ND<0.005 | ND<0.005 |
| | | | 2/3/2011 | ND<0.025 | ND<0.025 |
| | | | 4/13/2011 | ND<0.005 | ND<0.005 |
| | | | 8/16/2011 | ND<0.005 | ND<0.005 |
| | | | 10/26/2011 | ND<0.005 | ND<0.005 |
| | | | 1/18/2012 | ND<0.005 | ND<0.005 |
| B-51 | 29 | 29 (100%) | 11/15/2001 | ND<0.01 | ND<0.01 |
| | | | 4/2/2003 | ND<0.05 | ND<0.05 |
| | | | 10/9/2003 | ND<0.05 | ND<0.05 |
| | | | 1/7/2004 | ND<0.05 | ND<0.05 |
| | | | 4/7/2004 | ND<0.05 | ND<0.05 |
| | | | 7/13/2004 | ND<0.05 | ND<0.05 |
| | | | 10/6/2004 | ND<0.05 | ND<0.05 |
| | | | 1/6/2005 | ND<0.05 | ND<0.05 |
| | | | 4/6/2005 | ND<0.05 | ND<0.05 |
| | | | 7/27/2005 | ND<0.05 | ND<0.05 |
| | | | 10/13/2005 | ND<0.05 | ND<0.05 |
| | | | 1/5/2006 | ND<0.05 | ND<0.05 |
| | | | 4/6/2006 | ND<0.05 | ND<0.05 |
| | | | 7/25/2006 | ND<0.05 | ND<0.05 |
| | | | 10/11/2006 | ND<0.05 | ND<0.05 |
| | | | 1/4/2007 | ND<0.05 | ND<0.05 |
| | | | 4/4/2007 | ND<0.05 | ND<0.05 |
| | | | 7/12/2007 | ND<0.05 | ND<0.05 |
| | | | 10/10/2007 | ND<0.05 | ND<0.05 |
| | | | 7/23/2008 | ND<0.05 | ND<0.05 |
| | | | 10/22/2008 | ND<0.05 | ND<0.05 |
| | | | 1/14/2009 | ND<0.05 | ND<0.05 |
| | | | 4/8/2009 | ND<0.05 | ND<0.05 |
| | | | 7/15/2009 | ND<0.05 | ND<0.05 |
| | | | 1/7/2010 | ND<0.05 | ND<0.05 |
| | | | 4/7/2010 | ND<0.025 | ND<0.025 |
| | | | 7/7/2010 | ND<0.025 | ND<0.025 |
| | | | 8/16/2011 | ND<0.005 | ND<0.005 |
| | | | 10/26/2011 | ND<0.005 | ND<0.005 |

**Non-Parametric Prediction Interval**
**Inter-Well Comparison**
**Parameter: Barium, Dissolved**
**Original Data (Not Transformed)**

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 103
**Maximum Background Value = 0.418**
Confidence Level = 99%
False Positive Rate = 1%

| Location | Date | Count | Mean | Significant |
|---|---|---|---|---|
| B-30A | 4/4/2012 | 1 | 0.34 | FALSE |
| B-32 | 4/4/2012 | 1 | 0.043 | FALSE |
| DM-7 | 4/4/2012 | 1 | 0.013 | FALSE |
| DM-6 | 4/4/2012 | 1 | 0.008 | FALSE |
| B-31 | 4/4/2012 | 1 | 0.017 | FALSE |
| DM-5 | 4/4/2012 | 1 | 0.295 | FALSE |
| DM-1 | 4/4/2012 | 1 | 0.052 | FALSE |

## Shapiro-Francia Test of Normality (Continued)

**Parameter: Barium, Dissolved**

Background Locations

Normality Test of Parameter Concentrations

Natural Logarithm Transformation

Total Number of Measurements = 103

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | -1.92415 | 0.345126 | 48.5642 | 159.078 |
| 67 | -1.91732 | 0.371856 | 48.7025 | 158.365 |
| 68 | -1.91054 | 0.396142 | 48.8594 | 157.608 |
| 69 | -1.89048 | 0.423405 | 49.0387 | 156.808 |
| 70 | -1.88387 | 0.450985 | 49.2421 | 155.958 |
| 71 | -1.8579 | 0.476105 | 49.4688 | 155.074 |
| 72 | -1.85151 | 0.504372 | 49.7232 | 154.14 |
| 73 | -1.82635 | 0.530162 | 50.0042 | 153.172 |
| 74 | -1.78976 | 0.559237 | 50.317 | 152.171 |
| 75 | -1.7148 | 0.588793 | 50.6637 | 151.161 |
| 76 | -1.7148 | 0.615839 | 51.0429 | 150.105 |
| 77 | -1.69282 | 0.646431 | 51.4608 | 149.011 |
| 78 | -1.66601 | 0.67449 | 51.9157 | 147.887 |
| 79 | -1.6399 | 0.706302 | 52.4146 | 146.729 |
| 80 | -1.61445 | 0.738846 | 52.9605 | 145.536 |
| 81 | -1.58475 | 0.768821 | 53.5516 | 144.318 |
| 82 | -1.54178 | 0.802956 | 54.1963 | 143.08 |
| 83 | -1.53248 | 0.838054 | 54.8986 | 141.795 |
| 84 | -1.49165 | 0.87055 | 55.6565 | 140.497 |
| 85 | -1.47403 | 0.907769 | 56.4805 | 139.159 |
| 86 | -1.46534 | 0.942375 | 57.3686 | 137.778 |
| 87 | -1.44817 | 0.982202 | 58.3333 | 136.355 |
| 88 | -1.4397 | 1.02365 | 59.3812 | 134.882 |
| 89 | -1.41469 | 1.06252 | 60.5102 | 133.379 |
| 90 | -1.3823 | 1.10768 | 61.7371 | 131.847 |
| 91 | -1.3548 | 1.15035 | 63.0604 | 130.289 |
| 92 | -1.3356 | 1.20036 | 64.5013 | 128.686 |
| 93 | -1.33181 | 1.25357 | 66.0727 | 127.016 |
| 94 | -1.32803 | 1.30469 | 67.7749 | 125.284 |
| 95 | -1.31304 | 1.36581 | 69.6403 | 123.49 |
| 96 | -1.2694 | 1.4325 | 71.6924 | 121.672 |
| 97 | -1.20397 | 1.49852 | 73.938 | 119.868 |
| 98 | -1.20397 | 1.58047 | 76.4358 | 117.965 |
| 99 | -1.17766 | 1.66456 | 79.2066 | 116.004 |
| 100 | -0.994252 | 1.77438 | 82.355 | 114.24 |
| 101 | -0.972861 | 1.91103 | 86.007 | 112.381 |
| 102 | -0.941609 | 2.07485 | 90.312 | 110.427 |
| 103 | -0.872274 | 2.36561 | 95.9082 | 108.364 |

Data Set Standard Deviation = 1.14496

Numerator = 11742.7

Denominator = 12824.4

W Statistic = 0.915654 = 11742.7 / 12824.4

5% Critical value of 0.976 exceeds 0.915654

Evidence of non-normality at 95% level of significance

## Shapiro-Francia Test of Normality

**Parameter: Barium, Dissolved**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Natural Logarithm Transformation**
**Total Number of Measurements = 103**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | -4.60517 | -2.36561 | 5.59613 | 10.8941 |
| 2 | -4.60517 | -2.07485 | 9.90113 | 20.4491 |
| 3 | -4.60517 | -1.91103 | 13.5532 | 29.2497 |
| 4 | -4.50986 | -1.77438 | 16.7016 | 37.2519 |
| 5 | -4.50986 | -1.66456 | 19.4723 | 44.7588 |
| 6 | -4.50986 | -1.58047 | 21.9702 | 51.8865 |
| 7 | -4.42285 | -1.49852 | 24.2158 | 58.5142 |
| 8 | -4.42285 | -1.4325 | 26.2678 | 64.85 |
| 9 | -4.34281 | -1.36581 | 28.1333 | 70.7814 |
| 10 | -4.34281 | -1.30469 | 29.8355 | 76.4474 |
| 11 | -4.2687 | -1.25357 | 31.4069 | 81.7985 |
| 12 | -4.2687 | -1.20036 | 32.8478 | 86.9225 |
| 13 | -4.19971 | -1.15035 | 34.1711 | 91.7536 |
| 14 | -4.13517 | -1.10768 | 35.398 | 96.334 |
| 15 | -4.13517 | -1.06252 | 36.527 | 100.728 |
| 16 | -4.07454 | -1.02365 | 37.5748 | 104.899 |
| 17 | -4.07454 | -0.982202 | 38.5396 | 108.901 |
| 18 | -4.01738 | -0.942375 | 39.4276 | 112.687 |
| 19 | -4.01738 | -0.907769 | 40.2517 | 116.333 |
| 20 | -4.01738 | -0.87055 | 41.0095 | 119.831 |
| 21 | -4.01738 | -0.838054 | 41.7119 | 123.198 |
| 22 | -3.96332 | -0.802956 | 42.3566 | 126.38 |
| 23 | -3.96332 | -0.768821 | 42.9477 | 129.427 |
| 24 | -3.96332 | -0.738846 | 43.4936 | 132.355 |
| 25 | -3.91202 | -0.706302 | 43.9924 | 135.118 |
| 26 | -3.91202 | -0.67449 | 44.4474 | 137.757 |
| 27 | -3.86323 | -0.646431 | 44.8652 | 140.254 |
| 28 | -3.81671 | -0.615839 | 45.2445 | 142.605 |
| 29 | -3.81671 | -0.588793 | 45.5912 | 144.852 |
| 30 | -3.7297 | -0.559237 | 45.9039 | 146.938 |
| 31 | -3.68888 | -0.530162 | 46.185 | 148.893 |
| 32 | -3.61192 | -0.504372 | 46.4394 | 150.715 |
| 33 | -3.61192 | -0.476105 | 46.6661 | 152.435 |
| 34 | -3.50656 | -0.450985 | 46.8695 | 154.016 |
| 35 | -3.41125 | -0.423405 | 47.0487 | 155.461 |
| 36 | -3.27017 | -0.396142 | 47.2057 | 156.756 |
| 37 | -3.10109 | -0.371856 | 47.3439 | 157.909 |
| 38 | -2.74887 | -0.345126 | 47.463 | 158.858 |
| 39 | -2.74887 | -0.318639 | 47.5646 | 159.734 |
| 40 | -2.65926 | -0.294992 | 47.6516 | 160.518 |
| 41 | -2.6173 | -0.268908 | 47.7239 | 161.222 |
| 42 | -2.44185 | -0.24559 | 47.7842 | 161.822 |
| 43 | -2.44185 | -0.219834 | 47.8325 | 162.359 |
| 44 | -2.40795 | -0.194225 | 47.8703 | 162.826 |
| 45 | -2.40795 | -0.171285 | 47.8996 | 163.239 |
| 46 | -2.3969 | -0.1459 | 47.9209 | 163.588 |
| 47 | -2.34341 | -0.123135 | 47.9361 | 163.877 |
| 48 | -2.34341 | -0.0979139 | 47.9456 | 164.106 |
| 49 | -2.33304 | -0.0727562 | 47.9509 | 164.276 |
| 50 | -2.32279 | -0.0501541 | 47.9535 | 164.393 |
| 51 | -2.29263 | -0.0250691 | 47.9541 | 164.45 |
| 52 | -2.26336 | 0 | 47.9541 | 164.45 |
| 53 | -2.26336 | 0.0250691 | 47.9547 | 164.393 |
| 54 | -2.24432 | 0.0501541 | 47.9572 | 164.281 |
| 55 | -2.23493 | 0.0727562 | 47.9625 | 164.118 |
| 56 | -2.23493 | 0.0979139 | 47.9721 | 163.899 |
| 57 | -2.23493 | 0.123135 | 47.9873 | 163.624 |
| 58 | -2.18037 | 0.1459 | 48.0086 | 163.306 |
| 59 | -2.18037 | 0.171285 | 48.0379 | 162.933 |
| 60 | -2.17156 | 0.194225 | 48.0756 | 162.511 |
| 61 | -2.12026 | 0.219834 | 48.1239 | 162.045 |
| 62 | -2.10373 | 0.24559 | 48.1843 | 161.528 |
| 63 | -2.05573 | 0.268908 | 48.2566 | 160.975 |
| 64 | -2.02495 | 0.294992 | 48.3436 | 160.378 |
| 65 | -1.9951 | 0.318639 | 48.4451 | 159.742 |

## Shapiro-Francia Test of Normality (Continued)

**Parameter: Barium, Dissolved**

**Background Locations**

**Normality Test of Parameter Concentrations**

**Original Data (Not Transformed)**

**Total Number of Measurements = 103**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 66 | 0.146 | 0.345126 | 48.5642 | -0.481521 |
| 67 | 0.147 | 0.371856 | 48.7025 | -0.426858 |
| 68 | 0.148 | 0.396142 | 48.8594 | -0.368229 |
| 69 | 0.151 | 0.423405 | 49.0387 | -0.304295 |
| 70 | 0.152 | 0.450985 | 49.2421 | -0.235745 |
| 71 | 0.156 | 0.476105 | 49.4688 | -0.161473 |
| 72 | 0.157 | 0.504372 | 49.7232 | -0.0822868 |
| 73 | 0.161 | 0.530162 | 50.0042 | 0.0030692 |
| 74 | 0.167 | 0.559237 | 50.317 | 0.0964618 |
| 75 | 0.18 | 0.588793 | 50.6637 | 0.202445 |
| 76 | 0.18 | 0.615839 | 51.0429 | 0.313296 |
| 77 | 0.184 | 0.646431 | 51.4608 | 0.432239 |
| 78 | 0.189 | 0.67449 | 51.9157 | 0.559718 |
| 79 | 0.194 | 0.706302 | 52.4146 | 0.69674 |
| 80 | 0.199 | 0.738846 | 52.9605 | 0.843771 |
| 81 | 0.205 | 0.768821 | 53.5516 | 1.00138 |
| 82 | 0.214 | 0.802956 | 54.1963 | 1.17321 |
| 83 | 0.216 | 0.838054 | 54.8986 | 1.35423 |
| 84 | 0.225 | 0.87055 | 55.6565 | 1.55011 |
| 85 | 0.229 | 0.907769 | 56.4805 | 1.75798 |
| 86 | 0.231 | 0.942375 | 57.3686 | 1.97567 |
| 87 | 0.235 | 0.982202 | 58.3333 | 2.20649 |
| 88 | 0.237 | 1.02365 | 59.3812 | 2.4491 |
| 89 | 0.243 | 1.06252 | 60.5102 | 2.70729 |
| 90 | 0.251 | 1.10768 | 61.7371 | 2.98532 |
| 91 | 0.258 | 1.15035 | 63.0604 | 3.28211 |
| 92 | 0.263 | 1.20036 | 64.5013 | 3.5978 |
| 93 | 0.264 | 1.25357 | 66.0727 | 3.92874 |
| 94 | 0.265 | 1.30469 | 67.7749 | 4.27448 |
| 95 | 0.269 | 1.36581 | 69.6403 | 4.64189 |
| 96 | 0.281 | 1.4325 | 71.6924 | 5.04442 |
| 97 | 0.3 | 1.49852 | 73.938 | 5.49397 |
| 98 | 0.3 | 1.58047 | 76.4358 | 5.96811 |
| 99 | 0.308 | 1.66456 | 79.2066 | 6.4808 |
| 100 | 0.37 | 1.77438 | 82.355 | 7.13732 |
| 101 | 0.378 | 1.91103 | 86.007 | 7.85969 |
| 102 | 0.39 | 2.07485 | 90.312 | 8.66888 |
| 103 | 0.418 | 2.36561 | 95.9082 | 9.65771 |

Data Set Standard Deviation = 0.102801
Numerator = 93.2713
Denominator = 103.383
W Statistic = 0.902191 = 93.2713 / 103.383

5% Critical value of 0.976 exceeds 0.902191
Evidence of non-normality at 95% level of significance

**Shapiro-Francia Test of Normality**
**Parameter: Barium, Dissolved**
**Background Locations**
**Normality Test of Parameter Concentrations**
**Original Data (Not Transformed)**
**Total Number of Measurements = 103**

| i | x(i) | m(i) | sum(m^2) | sum(mx) |
|---|---|---|---|---|
| 1 | 0.01 | -2.36561 | 5.59613 | -0.0236561 |
| 2 | 0.01 | -2.07485 | 9.90113 | -0.0444046 |
| 3 | 0.01 | -1.91103 | 13.5532 | -0.0635149 |
| 4 | 0.011 | -1.77438 | 16.7016 | -0.0830331 |
| 5 | 0.011 | -1.66456 | 19.4723 | -0.101343 |
| 6 | 0.011 | -1.58047 | 21.9702 | -0.118728 |
| 7 | 0.012 | -1.49852 | 24.2158 | -0.136711 |
| 8 | 0.012 | -1.4325 | 26.2678 | -0.153901 |
| 9 | 0.013 | -1.36581 | 28.1333 | -0.171656 |
| 10 | 0.013 | -1.30469 | 29.8355 | -0.188617 |
| 11 | 0.014 | -1.25357 | 31.4069 | -0.206167 |
| 12 | 0.014 | -1.20036 | 32.8478 | -0.222972 |
| 13 | 0.015 | -1.15035 | 34.1711 | -0.240227 |
| 14 | 0.016 | -1.10768 | 35.398 | -0.25795 |
| 15 | 0.016 | -1.06252 | 36.527 | -0.27495 |
| 16 | 0.017 | -1.02365 | 37.5748 | -0.292353 |
| 17 | 0.017 | -0.982202 | 38.5396 | -0.30905 |
| 18 | 0.018 | -0.942375 | 39.4276 | -0.326013 |
| 19 | 0.018 | -0.907769 | 40.2517 | -0.342353 |
| 20 | 0.018 | -0.87055 | 41.0095 | -0.358022 |
| 21 | 0.018 | -0.838054 | 41.7119 | -0.373107 |
| 22 | 0.019 | -0.802956 | 42.3566 | -0.388364 |
| 23 | 0.019 | -0.768821 | 42.9477 | -0.402971 |
| 24 | 0.019 | -0.738846 | 43.4936 | -0.417009 |
| 25 | 0.02 | -0.706302 | 43.9924 | -0.431135 |
| 26 | 0.02 | -0.67449 | 44.4474 | -0.444625 |
| 27 | 0.021 | -0.646431 | 44.8652 | -0.4582 |
| 28 | 0.022 | -0.615839 | 45.2445 | -0.471749 |
| 29 | 0.022 | -0.588793 | 45.5912 | -0.484702 |
| 30 | 0.024 | -0.559237 | 45.9039 | -0.498124 |
| 31 | 0.025 | -0.530162 | 46.185 | -0.511378 |
| 32 | 0.027 | -0.504372 | 46.4394 | -0.524996 |
| 33 | 0.027 | -0.476105 | 46.6661 | -0.537851 |
| 34 | 0.03 | -0.450985 | 46.8695 | -0.55138 |
| 35 | 0.033 | -0.423405 | 47.0487 | -0.565353 |
| 36 | 0.038 | -0.396142 | 47.2057 | -0.580406 |
| 37 | 0.045 | -0.371856 | 47.3439 | -0.59714 |
| 38 | 0.064 | -0.345126 | 47.463 | -0.619228 |
| 39 | 0.064 | -0.318639 | 47.5646 | -0.63962 |
| 40 | 0.07 | -0.294992 | 47.6516 | -0.66027 |
| 41 | 0.073 | -0.268908 | 47.7239 | -0.6799 |
| 42 | 0.087 | -0.24559 | 47.7842 | -0.701267 |
| 43 | 0.087 | -0.219834 | 47.8325 | -0.720392 |
| 44 | 0.09 | -0.194225 | 47.8703 | -0.737872 |
| 45 | 0.09 | -0.171285 | 47.8996 | -0.753288 |
| 46 | 0.091 | -0.1459 | 47.9209 | -0.766565 |
| 47 | 0.096 | -0.123135 | 47.9361 | -0.778386 |
| 48 | 0.096 | -0.0979139 | 47.9456 | -0.787786 |
| 49 | 0.097 | -0.0727562 | 47.9509 | -0.794843 |
| 50 | 0.098 | -0.0501541 | 47.9535 | -0.799758 |
| 51 | 0.101 | -0.0250691 | 47.9541 | -0.80229 |
| 52 | 0.104 | 0 | 47.9541 | -0.80229 |
| 53 | 0.104 | 0.0250691 | 47.9547 | -0.799683 |
| 54 | 0.106 | 0.0501541 | 47.9572 | -0.794367 |
| 55 | 0.107 | 0.0727562 | 47.9625 | -0.786582 |
| 56 | 0.107 | 0.0979139 | 47.9721 | -0.776105 |
| 57 | 0.107 | 0.123135 | 47.9873 | -0.762929 |
| 58 | 0.113 | 0.1459 | 48.0086 | -0.746443 |
| 59 | 0.113 | 0.171285 | 48.0379 | -0.727087 |
| 60 | 0.114 | 0.194225 | 48.0756 | -0.704946 |
| 61 | 0:12 | 0.219834 | 48.1239 | -0.678566 |
| 62 | 0.122 | 0.24559 | 48.1843 | -0.648604 |
| 63 | 0.128 | 0.268908 | 48.2566 | -0.614184 |
| 64 | 0.132 | 0.294992 | 48.3436 | -0.575245 |
| 65 | 0.136 | 0.318639 | 48.4451 | -0.53191 |

**Rosner's Test for Outliers (Continued)**
**Parameter: Barium, Dissolved**
**Background Locations**
**Original Data (Not Transformed)**

---------------------------------------------
Iteration i = 3
Mean of 100 measurements = 0.11197
Std Dev = 0.09229
x(i+1) = 0.37 from measurement 10/10/2007 from location B-50
Rosner Statistic R = |0.37 - 0.11197|/0.09229 = 2.79586
Lambda(103, 4, 0.05) = 3.3784
2.79586 < 3.3784 -- No outliers detected for i = 3

---------------------------------------------
Iteration i = 2
Mean of 101 measurements = 0.114604
Std Dev = 0.0955666
x(i+1) = 0.378 from measurement 4/2/2003 from location B-50
Rosner Statistic R = |0.378 - 0.114604|/0.0955666 = 2.75615
Lambda(103, 3, 0.05) = 3.3878
2.75615 < 3.3878 -- No outliers detected for i = 2

---------------------------------------------
Iteration i = 1
Mean of 102 measurements = 0.117304
Std Dev = 0.0989248
x(i+1) = 0.39 from measurement 10/2/2003 from location B-50
Rosner Statistic R = |0.39 - 0.117304|/0.0989248 = 2.7566
Lambda(103, 2, 0.05) = 3.3878
2.7566 < 3.3878 -- No outliers detected for i = 1

---------------------------------------------
Iteration i = 0
Mean of 103 measurements = 0.120223
Std Dev = 0.102801
x(i+1) = 0.418 from measurement 10/6/2004 from location B-50
Rosner Statistic R = |0.418 - 0.120223|/0.102801 = 2.89664
Lambda(103, 1, 0.05) = 3.3884
2.89664 < 3.3884 -- No outliers detected for i = 0

**NO OUTLIERS DETECTED**

**Rosner's Test for Outliers**
**Parameter: Barium, Dissolved**
**Background Locations**
**Original Data (Not Transformed)**

Data set mean = 0.120223

10 most extreme of 103 measurements
by order of magnitude difference from the mean

| | | | | |
|---|---|---|---|---|
| 1 | 10/6/2004 | B-50 | 0.418 | 0.297777 |
| 2 | 10/2/2003 | B-50 | 0.39 | 0.269777 |
| 3 | 4/2/2003 | B-50 | 0.378 | 0.257777 |
| 4 | 10/10/2007 | B-50 | 0.37 | 0.249777 |
| 5 | 1/4/2007 | B-50 | 0.308 | 0.187777 |
| 6 | 1/7/2010 | B-50 | 0.3 | 0.179777 |
| 7 | 11/15/2001 | B-50 | 0.3 | 0.179777 |
| 8 | 4/4/2007 | B-50 | 0.281 | 0.160777 |
| 9 | 7/13/2004 | B-50 | 0.269 | 0.148777 |
| 10 | 7/23/2008 | B-50 | 0.265 | 0.144777 |

---------------------------------------------
Iteration i = 9
Mean of 94 measurements = 0.0996702
Std Dev = 0.0803259
x(i+1) = 0.265 from measurement 7/23/2008 from location B-50
Rosner Statistic R = |0.265 - 0.0996702|/0.0803259 = 2.05824
Lambda(103, 10, 0.05) = 3.359
2.05824 < 3.359 -- No outliers detected for i = 9

---------------------------------------------
Iteration i = 8
Mean of 95 measurements = 0.101453
Std Dev = 0.0817644
x(i+1) = 0.269 from measurement 7/13/2004 from location B-50
Rosner Statistic R = |0.269 - 0.101453|/0.0817644 = 2.04915
Lambda(103, 9, 0.05) = 3.36288
2.04915 < 3.36288 -- No outliers detected for i = 8

---------------------------------------------
Iteration i = 7
Mean of 96 measurements = 0.103323
Std Dev = 0.0833718
x(i+1) = 0.281 from measurement 4/4/2007 from location B-50
Rosner Statistic R = |0.281 - 0.103323|/0.0833718 = 2.13114
Lambda(103, 8, 0.05) = 3.36676
2.13114 < 3.36676 -- No outliers detected for i = 7

---------------------------------------------
Iteration i = 6
Mean of 97 measurements = 0.105351
Std Dev = 0.0853067
x(i+1) = 0.3 from measurement 11/15/2001 from location B-50
Rosner Statistic R = |0.3 - 0.105351|/0.0853067 = 2.28176
Lambda(103, 7, 0.05) = 3.37064
2.28176 < 3.37064 -- No outliers detected for i = 6

---------------------------------------------
Iteration i = 5
Mean of 98 measurements = 0.107337
Std Dev = 0.0871139
x(i+1) = 0.3 from measurement 1/7/2010 from location B-50
Rosner Statistic R = |0.3 - 0.107337|/0.0871139 = 2.21163
Lambda(103, 6, 0.05) = 3.37452
2.21163 < 3.37452 -- No outliers detected for i = 5

---------------------------------------------
Iteration i = 4
Mean of 99 measurements = 0.109364
Std Dev = 0.0889838
x(i+1) = 0.308 from measurement 1/4/2007 from location B-50
Rosner Statistic R = |0.308 - 0.109364|/0.0889838 = 2.23228
Lambda(103, 5, 0.05) = 3.3784
2.23228 < 3.3784 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
**Parameter: Barium, Dissolved**
**Original Data (Not Transformed)**
**Percent Background Non-Detects: 0%**
**Total Background Measurements: 103**
There are 3 background locations

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-50 | 37 | 0 (0%) | 11/15/2001 | 0.3 | 0.3 |
| | | | 4/3/2002 | 0.229 | 0.229 |
| | | | 4/2/2003 | 0.378 | 0.378 |
| | | | 10/2/2003 | 0.39 | 0.39 |
| | | | 1/7/2004 | 0.263 | 0.263 |
| | | | 4/7/2004 | 0.251 | 0.251 |
| | | | 7/13/2004 | 0.269 | 0.269 |
| | | | 10/6/2004 | 0.418 | 0.418 |
| | | | 1/6/2005 | 0.147 | 0.147 |
| | | | 4/6/2005 | 0.189 | 0.189 |
| | | | 7/27/2005 | 0.156 | 0.156 |
| | | | 10/13/2005 | 0.184 | 0.184 |
| | | | 1/5/2006 | 0.237 | 0.237 |
| | | | 4/6/2006 | 0.258 | 0.258 |
| | | | 7/25/2006 | 0.235 | 0.235 |
| | | | 10/11/2006 | 0.225 | 0.225 |
| | | | 1/4/2007 | 0.308 | 0.308 |
| | | | 4/4/2007 | 0.281 | 0.281 |
| | | | 7/12/2007 | 0.194 | 0.194 |
| | | | 10/10/2007 | 0.37 | 0.37 |
| | | | 1/16/2008 | 0.216 | 0.216 |
| | | | 4/3/2008 | 0.12 | 0.12 |
| | | | 7/23/2008 | 0.265 | 0.265 |
| | | | 10/22/2008 | 0.107 | 0.107 |
| | | | 1/13/2009 | 0.091 | 0.091 |
| | | | 4/8/2009 | 0.18 | 0.18 |
| | | | 7/15/2009 | 0.157 | 0.157 |
| | | | 10/8/2009 | 0.113 | 0.113 |
| | | | 1/7/2010 | 0.3 | 0.3 |
| | | | 4/7/2010 | 0.243 | 0.243 |
| | | | 7/7/2010 | 0.264 | 0.264 |
| | | | 12/8/2010 | 0.167 | 0.167 |
| | | | 2/3/2011 | 0.09 | 0.09 |
| | | | 4/13/2011 | 0.18 | 0.18 |
| | | | 8/16/2011 | 0.205 | 0.205 |
| | | | 10/26/2011 | 0.231 | 0.231 |
| | | | 1/18/2012 | 0.146 | 0.146 |

**Concentrations (mg/L)**
**Parameter: Barium, Dissolved**
**Original Data (Not Transformed)**
**Percent Background Non-Detects: 0%**
**Total Background Measurements: 103**
**There are 3 background locations**

| Loc. | Meas. | ND | Date | Conc. | Original |
|---|---|---|---|---|---|
| B-52 | 37 | 0 (0%) | 11/15/2001 | 0.025 | 0.025 |
| | | | 4/3/2002 | 0.02 | 0.02 |
| | | | 4/2/2003 | 0.027 | 0.027 |
| | | | 10/2/2003 | 0.022 | 0.022 |
| | | | 1/7/2004 | 0.019 | 0.019 |
| | | | 4/7/2004 | 0.012 J | 0.012 J |
| | | | 7/13/2004 | 0.016 | 0.016 |
| | | | 10/6/2004 | 0.038 | 0.038 |
| | | | 1/6/2005 | 0.011 J | 0.011 J |
| | | | 4/6/2005 | 0.012 J | 0.012 J |
| | | | 7/27/2005 | 0.018 | 0.018 |
| | | | 10/13/2005 | 0.018 | 0.018 |
| | | | 1/5/2006 | 0.024 | 0.024 |
| | | | 4/6/2006 | 0.017 | 0.017 |
| | | | 7/25/2006 | 0.019 | 0.019 |
| | | | 10/11/2006 | 0.02 | 0.02 |
| | | | 1/4/2007 | 0.018 | 0.018 |
| | | | 4/4/2007 | 0.014 J | 0.014 J |
| | | | 7/12/2007 | 0.011 J | 0.011 J |
| | | | 10/10/2007 | 0.033 | 0.033 |
| | | | 1/16/2008 | 0.03 | 0.03 |
| | | | 4/3/2008 | 0.01 J | 0.01 J |
| | | | 7/23/2008 | 0.017 | 0.017 |
| | | | 10/22/2008 | 0.013 J | 0.013 J |
| | | | 1/13/2009 | 0.01 J | 0.01 J |
| | | | 4/8/2009 | 0.027 | 0.027 |
| | | | 7/15/2009 | 0.015 | 0.015 |
| | | | 10/8/2009 | 0.013 | 0.013 |
| | | | 1/7/2010 | 0.045 | 0.045 |
| | | | 4/7/2010 | 0.016 | 0.016 |
| | | | 7/7/2010 | 0.021 | 0.021 |
| | | | 12/8/2010 | 0.018 | 0.018 |
| | | | 2/3/2011 | 0.019 | 0.019 |
| | | | 4/13/2011 | 0.011 J | 0.011 J |
| | | | 8/16/2011 | 0.014 J | 0.014 J |
| | | | 10/26/2011 | 0.022 | 0.022 |
| | | | 1/18/2012 | 0.01 J | 0.01 J |
| B-51 | 29 | 0 (0%) | 11/15/2001 | 0.087 | 0.087 |
| | | | 4/2/2003 | 0.151 | 0.151 |
| | | | 10/2/2003 | 0.152 | 0.152 |
| | | | 1/7/2004 | 0.096 | 0.096 |
| | | | 4/7/2004 | 0.122 | 0.122 |
| | | | 7/13/2004 | 0.101 | 0.101 |
| | | | 10/6/2004 | 0.199 | 0.199 |
| | | | 1/6/2005 | 0.073 | 0.073 |
| | | | 4/6/2005 | 0.087 | 0.087 |
| | | | 7/27/2005 | 0.104 | 0.104 |
| | | | 10/13/2005 | 0.106 | 0.106 |
| | | | 1/5/2006 | 0.113 | 0.113 |
| | | | 4/6/2006 | 0.107 | 0.107 |
| | | | 7/25/2006 | 0.128 | 0.128 |
| | | | 10/11/2006 | 0.104 | 0.104 |
| | | | 1/4/2007 | 0.114 | 0.114 |
| | | | 4/4/2007 | 0.161 | 0.161 |
| | | | 7/12/2007 | 0.09 | 0.09 |
| | | | 10/10/2007 | 0.214 | 0.214 |
| | | | 7/23/2008 | 0.132 | 0.132 |
| | | | 10/22/2008 | 0.064 | 0.064 |
| | | | 1/13/2009 | 0.07 | 0.07 |
| | | | 4/8/2009 | 0.148 | 0.148 |
| | | | 7/15/2009 | 0.097 | 0.097 |
| | | | 1/7/2010 | 0.107 | 0.107 |
| | | | 4/7/2010 | 0.096 | 0.096 |
| | | | 7/7/2010 | 0.136 | 0.136 |
| | | | 8/16/2011 | 0.098 | 0.098 |
| | | | 10/26/2011 | 0.064 | 0.064 |

**Attachment 8.d.**

**MEMORANDUM**

**DEPARTMENT OF ENVIRONMENTAL QUALITY**
***Piedmont Regional Office***

**4949-A Cox Road    Glen Allen, VA 23060    804/527-5020**

SUBJECT: VPDES Permit No. VA0004146
Chesterfield Power Station
Groundwater Quality and Risk Assessment Report- Phase I

TO: Curtis J. Linderman, P.E., Water Permit Manager

FROM: Emilee Carpenter, Water Permit Writer

DATE: February 8, 2013

COPIES: Donald Hintz, Dominion's Electric Environmental Services Group

Type of Report: Groundwater Quality and Risk Assessment Report – Phase I

Description: Phase I of the Groundwater Quality and Risk Assessment Report was submitted in accordance with Part I.B.7.b of the 2004 VPDES permit. Ground water monitoring data indicated that groundwater in the vicinity of the old ash pond has been affected, so DEQ requested a Corrective Action Plan (CAP) and schedule for assessing ground water contamination attributed to the Old Ash Pond in the 2004 permit. The report was initially submitted in February 2007, and subsequently revised in March of 2012. The goal of the report is to characterize the quality of groundwater in the area of the Old Ash Pond, assess current potential risk to human health and the environment from identified releases to groundwater, and evaluate whether corrective action or other actions are appropriate at the Facility. The report addresses the following:

1) Evaluation of Aquifer Characteristics:
    a. An updated potentiometric map based on 2012 GW elevations indicates radial flow away from the Old Ash Pond. The Old Ash Pond is bordered to the north by the Facility, to the West by the Facility discharge channel, to the south by the surface waters of Farrar Gut, to the east by Aiken Swamp, and to the southeast by the New Ash Pond.
    b. Hydraulic aquifer slug tests indicate overall average hydraulic conductivity of 0.52 ft/day.
    c. Average groundwater flow velocity beneath the Site is 5.36 ft/year

2) Evaluation of Background Monitoring Well Appropriateness:
    a. The background wells approved in the 2001 Groundwater Monitoring Plan (GWMP) were B-50, B-51 and B-52.
    b. Subsequent evaluation of the potentiometric map developed in 2012 indicates that wells B-50 and B-51 are located downgradient of the Old Ash Pond; however, B-52 remains an appropriate background well.
    c. Well B-51 does not meet performance standards as it has been dry 50% of the time over the last two years.
3) Characterization of Nature and Extent of Contamination
    a. Constituents of Potential Concern (COPC) were identified by comparing detected

constituents to EPA Regional Screening Levels (RSLs) for tap water (T-RSLs) and National Primary Drinking Water Regulations Maximum Contaminant Levels (MCLs). Analytes detected at a concentration higher than the corresponding T-RSL or MCL were selected as COPC. The following constituents were identified: dissolved arsenic, dissolved cadmium, dissolved iron, dissolved manganese, dissolved molybdenum.

b. Upper Prediction Limit (UPL) statistical analyses were used to evaluate the presence of statistically significant increases (SSIs) above background concentrations. Well B-52 was used as the sole background well. Data sets were evaluated for outliers using Dixon's test (Data sets less than 25) or Rosner's Test (data sets larger than 25). The appropriate method for UPL analysis was then determined based on the percent of non-detect data in the set and the normality of the distribution. Parametric and non-parametric approaches were chosen accordingly to perform the 95% Prediction Interval Analysis. The following parameters showed SSIs over background concentrations: dissolved arsenic, dissolved barium, dissolved copper, dissolved iron, dissolved manganese, dissolved molybdenum, ammonia, and chloride. Background statistical evaluations also indicate that identified COPC from 3.a above also show SSI above site background levels.

4) Identification of Human Health and Environmental Receptors:
   a. Groundwater:
      i. Although none of the groundwater sources at the site or on bordering industrial parcels are currently used as drinking water sources, human health receptors of contaminated groundwater are based on the assumption that the groundwater is used as drinking water. The only current scenario receptors are construction workers. Future hypothetical receptors are Commercial/Industrial workers and child and adult residents.
      ii. Exposure pathways to human receptors include ingestion, dermal absorption and inhalation.
   b. Surface water:
      i. Surface water receptors include Farrar Gut and Aiken Swamp. Contamination of surface waters presents potential risks to both human health and aquatic life.
      ii. Exposure pathways to human receptors include recreational use and potential future public water supply use. Exposure to aquatic organisms is chronic ambient environmental conditions.
5) Assessment of Risk to Identified Receptors:
   a. Groundwater: To evaluate the risk of hypothetical current or future use of groundwater on site for potable applications (i.e. drinking, showering, etc.), a Human Health Risk Assessment (HHRA) was performed consistent with EPA guidance, Interim Final Risk Assessment Guidance for Superfund (RAGS) and other EPA Region III resources and guidance documents.
      i. COPC were identified for the April 2011 sampling results by comparing detected constituent concentrations to EPA Regional Screening Levels and National Primary Drinking Water Regulations, MCLs. Analytes detected at a concentration higher than the corresponding RSL or MCL are selected as COPC.
      ii. Constituents identified as COPC are as follows: dissolved iron, dissolved manganese, dissolved arsenic, dissolved molybdenum, and dissolved cadmium.
      iii. Carcinogenic COPC were not identified in the groundwater, so an associated risk was not calculated. Non-carcinogenic risks were calculated in cumulative for each exposure pathway to form a Hazard Index (HI), which accounts for simultaneous exposure to multiple COPC.

- iv. Elevated HIs were found for future receptors due to iron and manganese if the groundwater were to be used as drinking/bathing water and partly due to ammonia inhalation in a shower scenario.
- v. Groundwater at the site is not currently nor expected in the future to be used as tap water for drinking, washing or bathing; therefore, the exposure pathway is incomplete.

b. Surface Water: A two-tiered screening approach was used to evaluate potential risks. Surface water data were collected from 3 locations in Aiken Swamp, 4 locations in Farrar Gut and one background location upstream of the Facility in the James River.

- i. Tier I consists of comparing receptor surface water data to background surface water data to determine whether an increase over background is observed. If an increase is observed, a potential effect on water quality is identified and the Tier II comparison must be performed.
- ii. Tier II consists of comparison of surface water data to conservative human and ecological risk screening criteria.
  1. Aiken Swamp:
     - a. Tier I: Background concentrations for arsenic, barium, iron, manganese, vanadium, zinc, ammonia, chloride and sulfate were exceeded in 2006. The 2012 sampling event identified a smaller number of constituents that exceeded background: iron, manganese, ammonia and chloride.
     - b. Tier II: As a swamp, it is highly unlikely that this receptor will be used in the future as a public water supply (PWS). Consequently, Aiken Swamp was screened against the Virginia Water Quality Standards for freshwater aquatic life (chronic toxicity) and for Human Health-“all other surface waters.” Observed concentrations were below the criteria; consequently, it does not appear a potential risk is posed to human or aquatic life in Aiken Swamp.
  2. Farrar Gut:
     - a. Tier I: Background concentrations for barium, chromium, copper, manganese, molybdenum, vanadium, zinc, and sulfate were exceeded in 2006. The 2012 sampling event identified background exceedances for barium, iron, manganese, molybdenum, ammonia, chloride, nitrate and sulfate.
     - b. Tier II:
       - i. Surface water data was compared to VWQS for public water supplies and all other surface waters. Observed concentrations were below the standards, with the exception of iron and manganese standards for PWSs. Iron and manganese standards for PWS are established based on the aesthetic quality of drinking water and apply at the drinking water intake. Therefore, it does not appear that the surface water poses a potential risk with regard to human health.
       - ii. Surface water data was also compared to the VWQS for fresh water aquatic species (chronic toxicity). All observed concentrations were below the standards with the exception of a single hexavalent chromium sample collected in 2006. The observed concentration of total hexavalent chromium exceeded the standard by 1 µg/L. The standard is expressed in terms of dissolved hexavalent chromium, which was not detected in any of the surface water samples. Consequently, the results did not indicate a potential risk to aquatic life in Farrar Gut.

iii. While surface water is a complete pathway for both human and ecological receptors, the human health and aquatic life risk screenings did not indicate a current risk to receptors from discharges of site groundwater to surface water.

6) Evaluation of the need for remedial alternatives:
   a. In a subsequent submittal, dated November 29, 2012 Dominion proposed to address future risk assessment and corrective action through Phase II of the report. Dominion proposes to establish groundwater action levels in a manner similar to the approach used for the New Ash Pond.
      i. Action levels will be established for the Constituents of Potential Concern (COPCs) in the Revised Groundwater Quality and Risk Assessment Report.
      ii. Submittal of Phase II of the Report will be required within 180 days of the effective date of the reissued permit. This requirement will be addressed in the groundwater monitoring special condition of the reissued permit

Recommendation: Staff recommends approval of Phase I of the Groundwater Quality and Risk Assessment Report. Approval is contingent upon submittal of a Phase II report to address future risk assessment and corrective action. In addition to the proposed action level approach for COPCs identified above, the permittee must also address migration of the groundwater contaminant plume onto neighboring industrial properties and ensure that Ground Water Standards and Criteria are met at the property boundary.

Approved: As recommended by staff.

Curtis J. Linderman, P.E.
Water Permit Manager,
VA Department of Environmental Quality

Date: February 12, 2013

Attachment 8.e

Metals Pond Statistical Analysis

# Groundwater Monitoring Data Analysis (v.3)

| | |
|---|---|
| Facility Name: | Dominion-CPS |
| Permit No.: | VA0004146 |
| Monitoring Parameter: | chloride |
| Applicable GW Standard (if none leave blank): | |
| Applicable GW Criteria (if none leave blank): | 50 |
| Concentration Units (all data): | mg/L |

| | | Data Entry | | | | | |
|---|---|---|---|---|---|---|---|
| | Well Designation ? | B52 | MP-1 | MP-2 | MP-3 | | |
| | Sample or Report Date (ascending) | Background Well Data | Compliance Well #1 | Compliance Well #2 | Compliance Well #3 | Compliance Well #4 | Compliance Well #5 |
| 1 | 7/23/2008 | 8.61 | 41.71 | 7.77 | 59.1 | | |
| 2 | 10/22/2008 | 8.33 | 27.42 | 6.98 | 58.34 | | |
| 3 | 1/13/2009 | 8.6 | 19.02 | 7.41 | 57.7 | | |
| 4 | 4/8/2009 | 8.58 | 37.24 | 7.05 | 57.2 | | |
| 5 | 7/15/2009 | 8.51 | 34.42 | 7.1 | 54.92 | | |
| 6 | 10/8/2009 | 9.1 | 19.44 | 7.28 | 60.9 | | |
| 7 | 1/7/2010 | 8.91 | 21.29 | 7.59 | 61 | | |
| 8 | 4/7/2010 | 8.62 | 17.13 | 12.99 | 65.43 | | |
| 9 | 7/7/2010 | 8.74 | 18.3 | 21.34 | 76.08 | | |
| 10 | 12/8/2010 | 8.74 | 23.41 | 28.09 | 104.37 | | |
| 11 | 2/3/2011 | 8.84 | 21.38 | 19 | 117.3 | | |
| 12 | 4/13/2011 | 9.34 | 19.72 | 18.95 | 133.93 | | |
| 13 | 8/16/2011 | 11.01 | 34.84 | 29.36 | 148.74 | | |
| 14 | 10/16/2011 | 28.76 | 34.81 | 11.52 | 178.03 | | |
| 15 | 1/18/2012 | 17.91 | 40.55 | 23.83 | 220.02 | | |
| 16 | 4/4/2012 | 9.17 | 38.76 | 31.16 | 248.05 | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
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| 49 | | | | | | | |
| 50 | | | | | | | |

Results: Significance to Background

| | Distribution Tests | | Non-normal Test | Normal Tests | |
|---|---|---|---|---|---|
| | Shapiro-Wilk Normality Test | Shapiro-Wilk Log-Normality Test | Wilcoxon Rank Sum Test | T-test | T-test (lognormal) |
| Background Well | Not normal | Not normal | N/A | | |
| Compliance Well #1 | Not normal | Not normal | Significant | Significant | Significant |
| Compliance Well #2 | Not normal | Not normal | Not Significant | Significant | Not Significant |
| Compliance Well #3 | Not normal | Not normal | Significant | Significant | Significant |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

Results: Linear Regression Trend Analysis and Interpretation of Data

| | Regression Line Slope | Pearson Correlation (R) | Interpretation | |
|---|---|---|---|---|
| | | | Linear Trend | Degree of Data Linearity |
| Background Well | 0.00604521 | 0.495355744 | Slight Increase | Moderately Weak |
| Compliance Well #1 | 0.003104563 | 0.150200721 | Slight Increase | Very Weak |
| Compliance Well #2 | 0.016714334 | 0.812083074 | Slight Increase | Very Strong |
| Compliance Well #3 | 0.128649967 | 0.8934081 | Slight Increase | Very Strong |
| Compliance Well #4 | | | | |
| Compliance Well #5 | | | | |

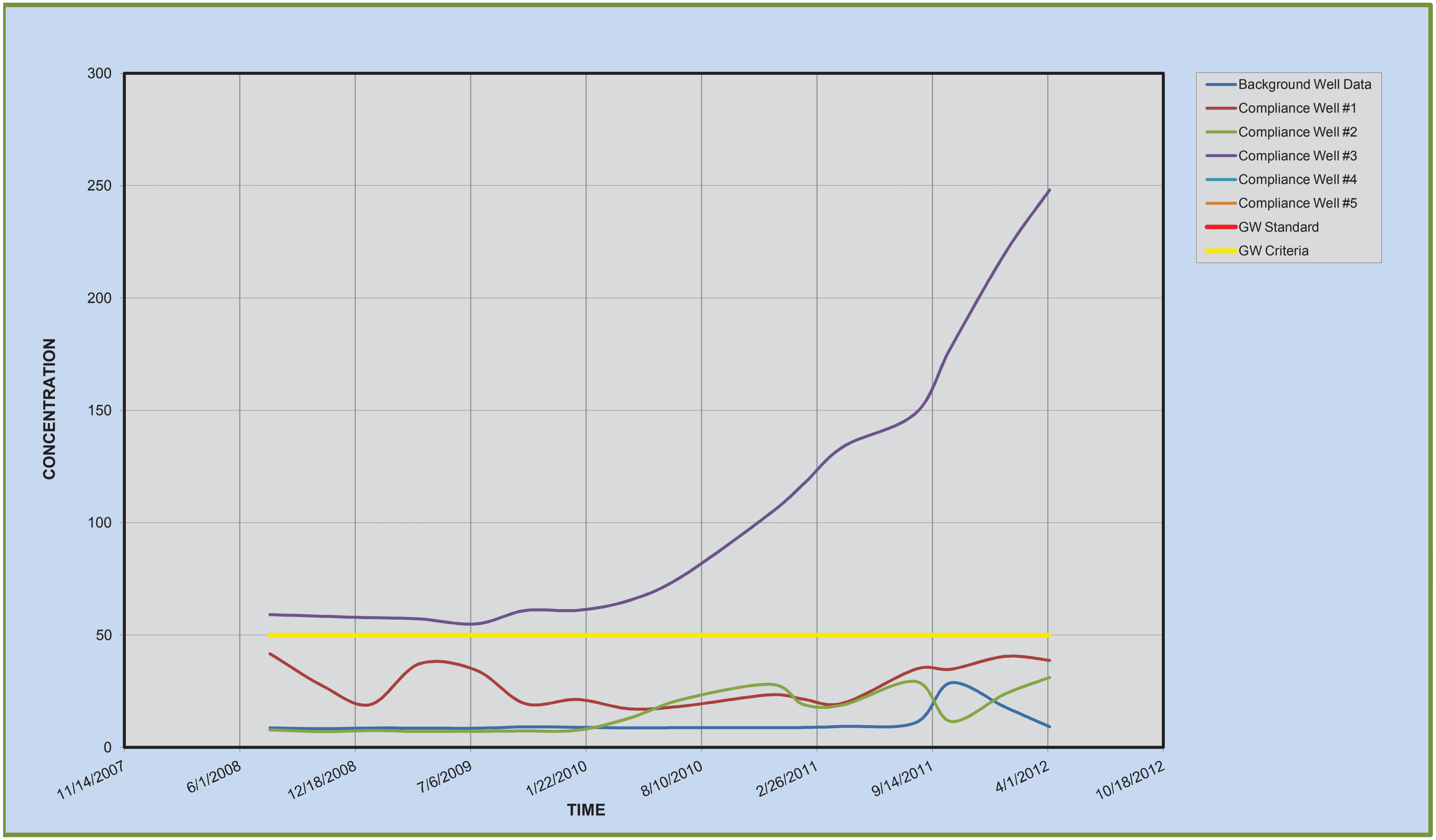
Results: Groundwater Standards/Criteria Comparison

| | Groundwater Standard | | Groundwater Criteria | | Total No. of Data Points |
|---|---|---|---|---|---|
| | No. Violations of GW Standard | % Violations of GW Standard | No. Violations of GW Criteria | % Violations of GW Criteria | |
| Background Well | | | 0 | 0% | 16 |
| Compliance Well #1 | | | 0 | 0% | 16 |
| Compliance Well #2 | | | 0 | 0% | 16 |
| Compliance Well #3 | | | 16 | 100% | 16 |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

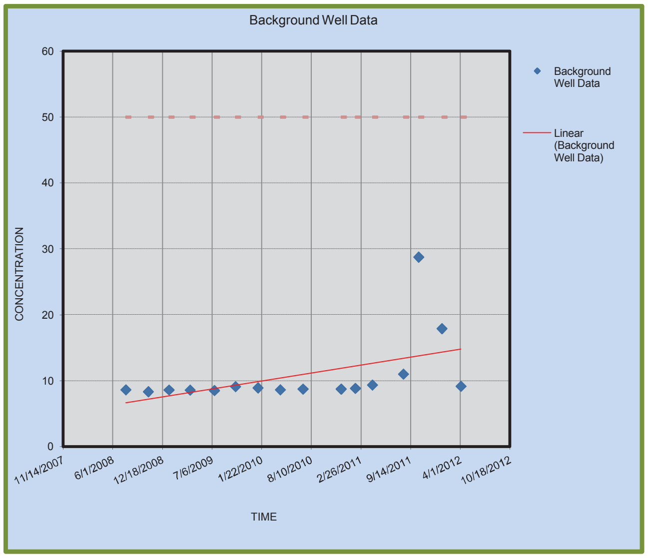
Results: Basic Statistics (less-than values ignored)

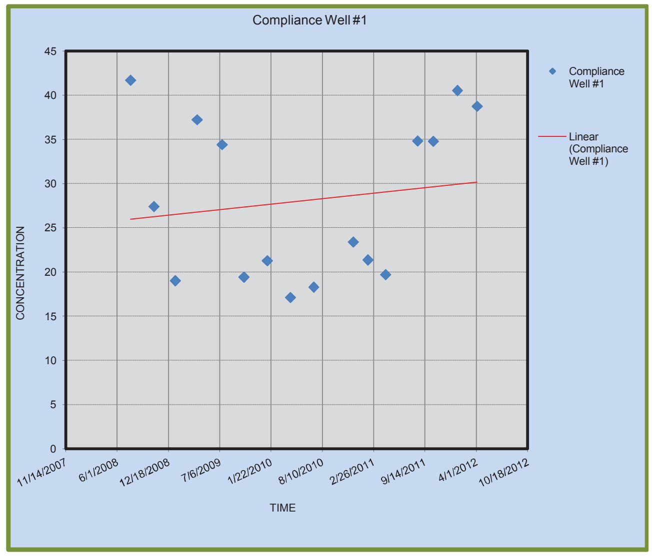
| | Maximum Value | Minimum Value | Average | | |
|---|---|---|---|---|---|
| Background Well | 29 | 8 | 11 | | |
| Compliance Well #1 | 42 | 17 | 28 | | |
| Compliance Well #2 | 31 | 7 | 15 | | |
| Compliance Well #3 | 248 | 55 | 106 | | |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

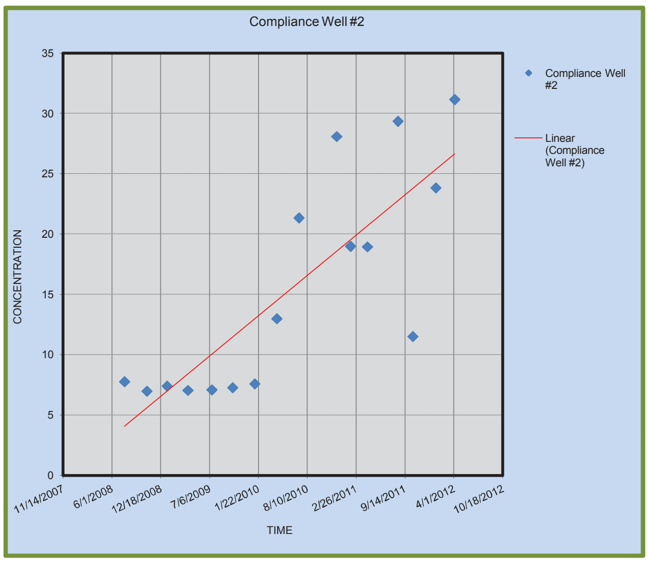
## Dominion-CPS: Groundwater Monitoring Data for chloride

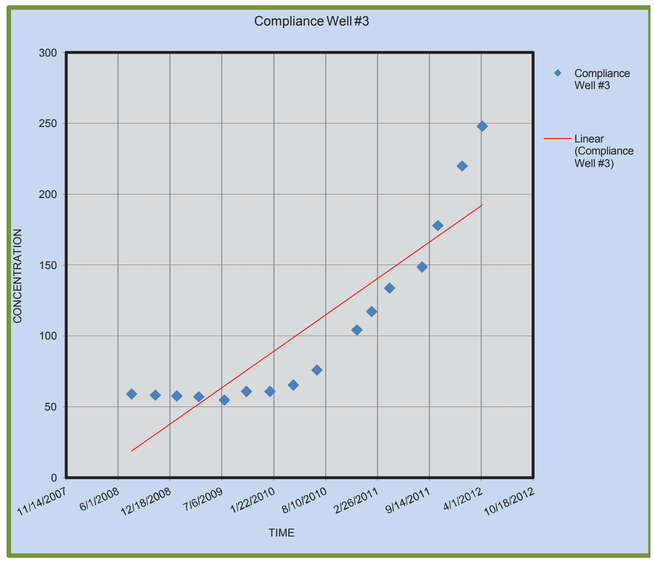


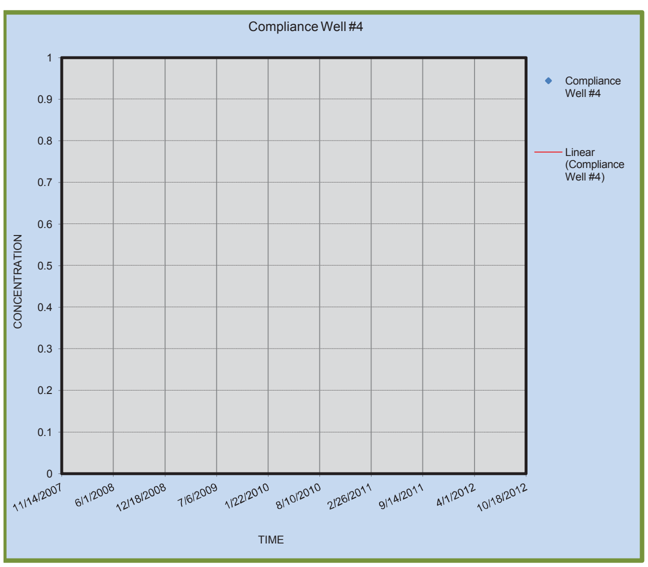
# Dominion-CPS: Groundwater Monitoring Regression Trends for chloride

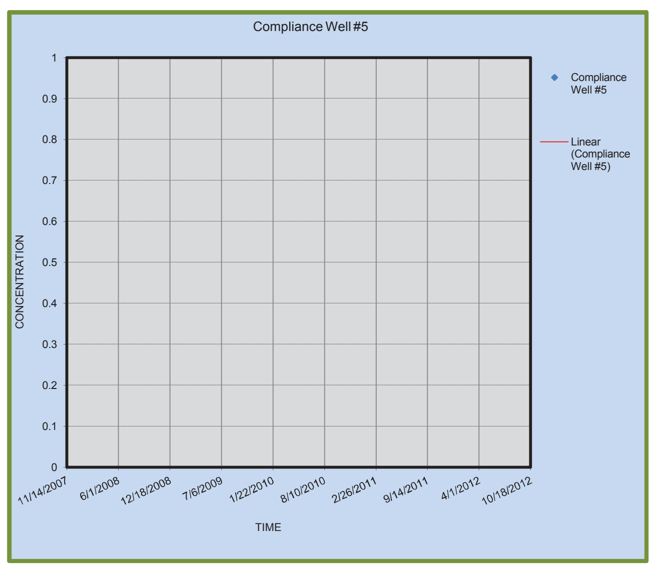


# Groundwater Monitoring Data Analysis (v.3)

| | |
|---|---|
| Facility Name: | Dominion- CPS |
| Permit No.: | VA0004146 |
| Monitoring Parameter: | Conductivity |
| Applicable GW Standard (if none leave blank): | |
| Applicable GW Criteria (if none leave blank): | |
| Concentration Units (all data): | umhos/cm |

| | | Data Entry | | | | | |
|---|---|---|---|---|---|---|---|
| | Well Designation ? | B52 | MP-1 | MP-2 | MP-3 | | |
| | Sample or Report Date (ascending) | Background Well Data | Compliance Well #1 | Compliance Well #2 | Compliance Well #3 | Compliance Well #4 | Compliance Well #5 |
| 1 | 11/15/2001 | 461 | 83 | 306 | 498 | | |
| 2 | 1/16/2002 | 570 | 95 | 361 | 532 | | |
| 3 | 4/3/2002 | 615 | 113 | 377 | 547 | | |
| 4 | 7/2/2002 | 480 | 88 | 311 | 475 | | |
| 5 | 10/2/2002 | 547 | 86 | 333 | 508 | | |
| 6 | 1/8/2003 | 627 | 151 | 362 | 587 | | |
| 7 | 4/2/2003 | 417 | 111 | 298 | 750 | | |
| 8 | 7/23/2003 | 487 | 103 | 318 | 558 | | |
| 9 | 10/2/2003 | 771 | 87 | 289 | 613 | | |
| 10 | 1/7/2004 | 530 | 193 | 325 | 589 | | |
| 11 | 4/7/2004 | 739 | 94 | 275 | 552 | | |
| 12 | 7/13/2004 | 533 | 97 | 320 | 633 | | |
| 13 | 10/6/2004 | 536 | 93 | 266 | 574 | | |
| 14 | 1/6/2005 | 745 | 107 | 272 | 564 | | |
| 15 | 4/6/2005 | 538 | 109 | 259 | 547 | | |
| 16 | 7/27/2005 | 520 | 98 | 287 | 557 | | |
| 17 | 10/13/2005 | 876 | 102 | 305 | 578 | | |
| 18 | 1/5/2006 | 558 | 107 | 290 | 547 | | |
| 19 | 4/6/2006 | 546 | 309 | 273 | 548 | | |
| 20 | 7/25/2006 | 588 | 216 | 275 | 557 | | |
| 21 | 10/11/2006 | 853 | 221 | 292 | 557 | | |
| 22 | 1/4/2007 | 712 | 260 | 249 | 483 | | |
| 23 | 4/4/2007 | 576 | 166 | 259 | 542 | | |
| 24 | 7/12/2007 | 478 | 160 | 242 | 511 | | |
| 25 | 10/10/2007 | 632 | 249 | 256 | 539 | | |
| 26 | 1/16/2008 | 549 | 248 | 245 | 513 | | |
| 27 | 4/3/2008 | 571 | 200 | 261 | 519 | | |
| 28 | 7/23/2008 | 538 | 209 | 268 | 541 | | |
| 29 | 10/22/2008 | 527 | 220 | 253 | 518 | | |
| 30 | 1/13/2009 | 548 | 215 | 265 | 554 | | |
| 31 | 4/8/2009 | 546 | 231 | 285 | 540 | | |
| 32 | 7/15/2009 | 690 | 221 | 288 | 571 | | |
| 33 | 10/8/2009 | 491 | 210 | 279 | 535 | | |
| 34 | 1/7/2010 | 665 | 207 | 283 | 589 | | |
| 35 | 4/7/2010 | 719 | 124 | 292 | 629 | | |
| 36 | 7/7/2010 | 521 | 173 | 277 | 610 | | |
| 37 | 12/8/2010 | 539 | 236 | 304 | 657 | | |
| 38 | 2/3/2011 | 583 | 231 | 318 | 662 | | |
| 39 | 4/13/2011 | 603 | 238 | 347 | 745 | | |
| 40 | 8/16/2011 | 675 | 220 | 349 | 800 | | |
| 41 | 10/16/2011 | 657 | 307 | 320 | 900 | | |
| 42 | 1/18/2012 | 702 | 297 | 329 | 945 | | |
| 43 | 4/4/2012 | 596 | 330 | 640 | 1062 | | |
| 44 | | | | | | | |
| 45 | | | | | | | |
| 46 | | | | | | | |
| 47 | | | | | | | |
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| 50 | | | | | | | |

Results: Significance to Background

| | Distribution Tests | | Non-normal Test | Normal Tests | |
|---|---|---|---|---|---|
| | Shapiro-Wilk Normality Test | Shapiro-Wilk Log-Normality Test | Wilcoxon Rank Sum Test | T-test | T-test (lognormal) |
| Background Well | Not normal | Not normal | N/A | | |
| Compliance Well #1 | Not normal | Not normal | Not Significant | Not Significant | Not Significant |
| Compliance Well #2 | Not normal | Not normal | Not Significant | Not Significant | Not Significant |
| Compliance Well #3 | Not normal | Not normal | Not Significant | Not Significant | Not Significant |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

Results: Linear Regression Trend Analysis and Interpretation of Data

| | Regression Line Slope | Pearson Correlation (R) | Interpretation | |
|---|---|---|---|---|
| | | | Linear Trend | Degree of Data Linearity |
| Background Well | 0.014448532 | 0.162783906 | Slight Increase | Very Weak |
| Compliance Well #1 | 0.048488122 | 0.768857618 | Slight Increase | Very Strong |
| Compliance Well #2 | 0.006068772 | 0.111697559 | Slight Increase | Very Weak |
| Compliance Well #3 | 0.058305403 | 0.542458933 | Slight Increase | Moderately Strong |
| Compliance Well #4 | | | | |
| Compliance Well #5 | | | | |

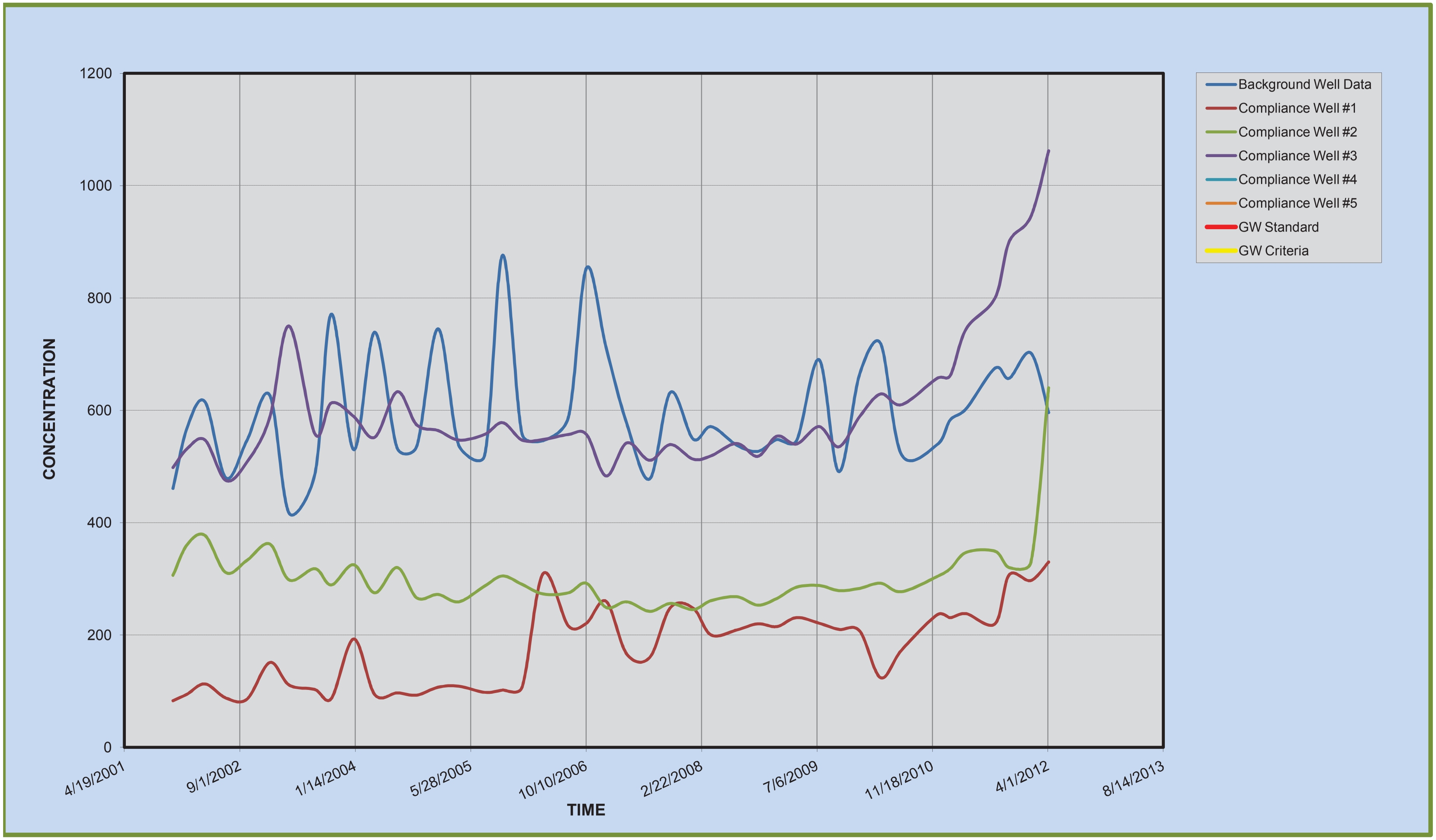
Results: Groundwater Standards/Criteria Comparison

| | Groundwater Standard | | Groundwater Criteria | | Total No. of Data Points |
|---|---|---|---|---|---|
| | No. Violations of GW Standard | % Violations of GW Standard | No. Violations of GW Criteria | % Violations of GW Criteria | |
| Background Well | | | | | 43 |
| Compliance Well #1 | | | | | 43 |
| Compliance Well #2 | | | | | 43 |
| Compliance Well #3 | | | | | 43 |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

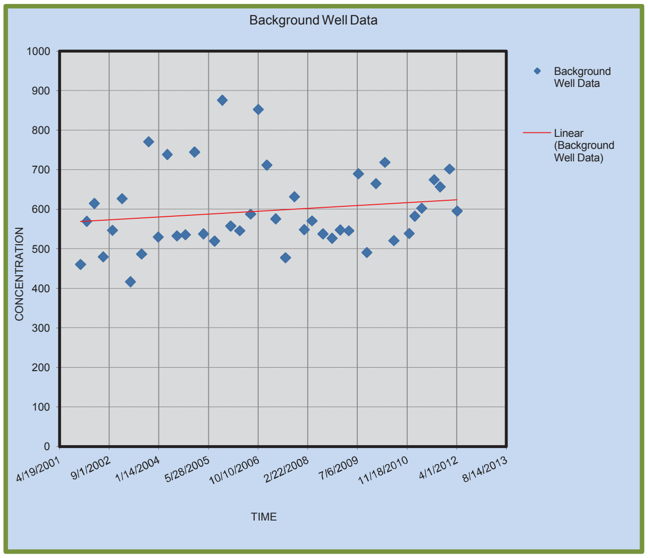
Results: Basic Statistics (less-than values ignored)

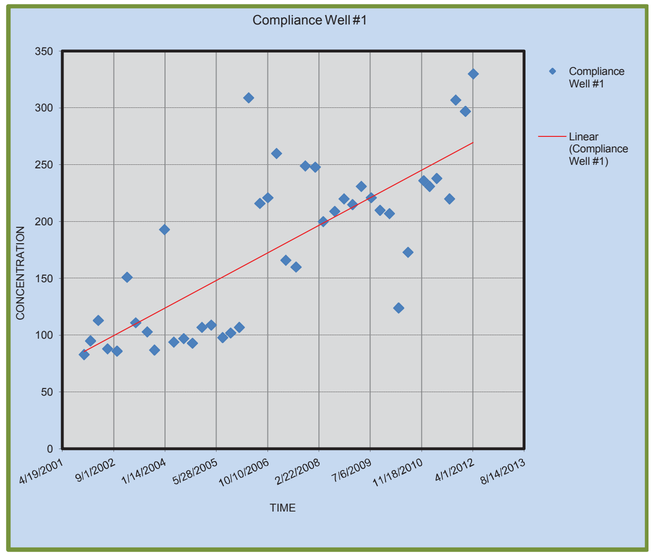
| | Maximum Value | Minimum Value | Average | | |
|---|---|---|---|---|---|
| Background Well | 876 | 417 | 597 | | |
| Compliance Well #1 | 330 | 83 | 177 | | |
| Compliance Well #2 | 640 | 242 | 302 | | |
| Compliance Well #3 | 1062 | 475 | 601 | | |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

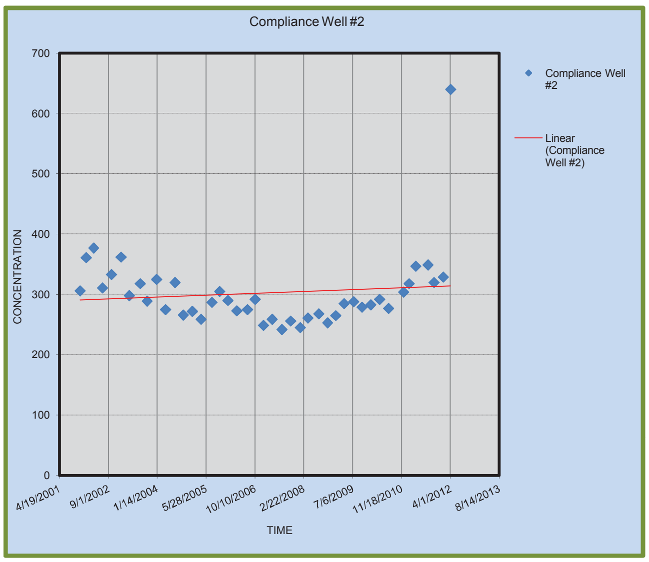
**Dominion- CPS: Groundwater Monitoring Data for Conductivity**

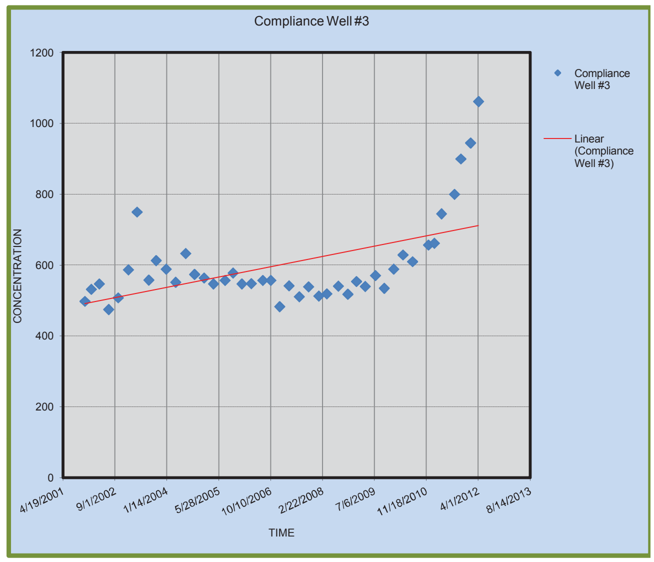


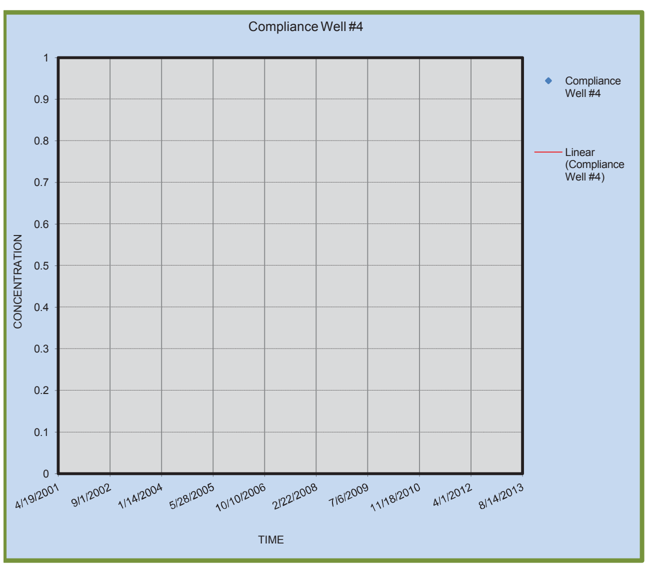
## Dominion- CPS: Groundwater Monitoring Regression Trends for Conductivity

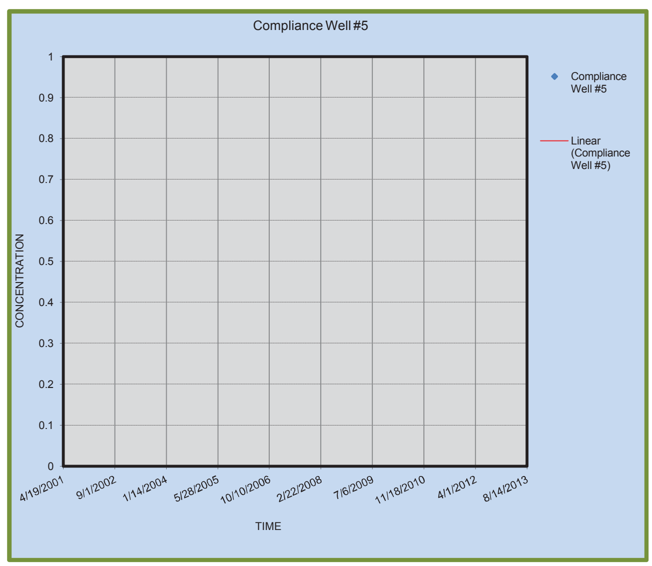


# Groundwater Monitoring Data Analysis (v.3)

| | |
|---|---|
| Facility Name: | Dominion-CPS |
| Permit No.: | VA0004146 |
| Monitoring Parameter: | Copper |
| Applicable GW Standard (if none leave blank): | 1000 |
| Applicable GW Criteria (if none leave blank): | |
| Concentration Units (all data): | ug/L |

| | | Data Entry | | | | | |
|---|---|---|---|---|---|---|---|
| | Well Designation ? | B52 | MP-1 | MP-2 | MP-3 | | |
| | Sample or Report Date (ascending) | Background Well Data | Compliance Well #1 | Compliance Well #2 | Compliance Well #3 | Compliance Well #4 | Compliance Well #5 |
| 1 | 11/15/2001 | 1 | 1 | 1 | 1 | | |
| 2 | 1/16/2002 | 1 | 1 | 1 | 1 | | |
| 3 | 4/3/2002 | 1 | 3 | 2 | 4 | | |
| 4 | 7/2/2002 | 5 | 2 | 2 | 6 | | |
| 5 | 10/2/2002 | 1 | 1 | 1 | 1 | | |
| 6 | 1/8/2003 | 2 | 1 | 1 | 1 | | |
| 7 | 4/2/2003 | 1 | 2 | 1 | 2 | | |
| 8 | 7/23/2003 | 1 | 1 | 1 | 1 | | |
| 9 | 10/2/2003 | 1 | 1 | 1 | 1 | | |
| 10 | 1/7/2004 | 2 | 1 | 1 | 1 | | |
| 11 | 4/7/2004 | 1 | 1 | 1 | 1 | | |
| 12 | 7/13/2004 | 1 | 1 | 1 | 1 | | |
| 13 | 10/6/2004 | 4 | 1 | 1 | 1 | | |
| 14 | 1/6/2005 | 1 | 1 | 1 | 1 | | |
| 15 | 4/6/2005 | 2 | 2 | 1 | 1 | | |
| 16 | 7/27/2005 | 1 | 1 | 1 | 1 | | |
| 17 | 10/13/2005 | 1 | 1 | 1 | 1 | | |
| 18 | 1/5/2006 | 1 | 1 | 1 | 1 | | |
| 19 | 4/6/2006 | 1 | 1 | 1 | 1 | | |
| 20 | 7/25/2006 | 1 | 1 | 1 | 1 | | |
| 21 | 10/11/2006 | 1 | 1 | 1 | 1 | | |
| 22 | 1/4/2007 | 1 | 1 | 1 | 1 | | |
| 23 | 4/4/2007 | 1 | 1 | 1 | 1 | | |
| 24 | 7/12/2007 | 1 | 1 | 1 | 1 | | |
| 25 | 10/10/2007 | 1 | 1 | 1 | 1 | | |
| 26 | 1/16/2008 | 1 | 1 | 1 | 1 | | |
| 27 | 4/3/2008 | 1 | 1 | 1 | 1 | | |
| 28 | 7/23/2008 | 2 | 2 | 1 | 1 | | |
| 29 | 10/22/2008 | 1 | 1 | 1 | 1 | | |
| 30 | 1/13/2009 | 1 | 1 | 1 | 2 | | |
| 31 | 4/8/2009 | 1 | 1 | 1 | 1 | | |
| 32 | 7/15/2009 | 1 | 1 | 1 | 1 | | |
| 33 | 10/8/2009 | 1 | 1 | 1 | 1 | | |
| 34 | 1/7/2010 | 1 | 1 | 1 | 2 | | |
| 35 | 4/7/2010 | 3 | 1 | 1 | 2 | | |
| 36 | 7/7/2010 | 1 | 1 | 1 | 1 | | |
| 37 | 12/8/2010 | 1 | 2 | 1 | 1 | | |
| 38 | 2/3/2011 | 1 | 1 | 1 | 1 | | |
| 39 | 4/13/2011 | 1 | 1 | 4 | 1 | | |
| 40 | 8/16/2011 | 2 | 1 | 1 | 1 | | |
| 41 | 10/16/2011 | 1 | 1 | 1 | 2 | | |
| 42 | 1/18/2012 | 1 | 1 | 1 | 1 | | |
| 43 | 4/4/2012 | 1 | 1 | 1 | 1 | | |
| 44 | | | | | | | |
| 45 | | | | | | | |
| 46 | | | | | | | |
| 47 | | | | | | | |
| 48 | | | | | | | |
| 49 | | | | | | | |
| 50 | | | | | | | |

Results: Significance to Background

| | Distribution Tests | | Non-normal Test | Normal Tests | |
|---|---|---|---|---|---|
| | Shapiro-Wilk Normality Test | Shapiro-Wilk Log-Normality Test | Wilcoxon Rank Sum Test | T-test | T-test (lognormal) |
| Background Well | Not normal | Not normal | N/A | | |
| Compliance Well #1 | Not normal | Not normal | Not Significant | Not Significant | Not Significant |
| Compliance Well #2 | Not normal | Not normal | Not Significant | Not Significant | Not Significant |
| Compliance Well #3 | Not normal | Not normal | Not Significant | Not Significant | Not Significant |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

Results: Linear Regression Trend Analysis and Interpretation of Data

| | Regression Line Slope | Pearson Correlation (R) | Interpretation | |
|---|---|---|---|---|
| | | | Linear Trend | Degree of Data Linearity |
| Background Well | -0.000139245 | -0.191273343 | Slight Decrease | Very Weak |
| Compliance Well #1 | -9.35363E-05 | -0.248664103 | Slight Decrease | Very Weak |
| Compliance Well #2 | 2.25019E-05 | 0.051960375 | Slight Increase | Very Weak |
| Compliance Well #3 | -0.000182965 | -0.230281424 | Slight Decrease | Very Weak |
| Compliance Well #4 | | | | |
| Compliance Well #5 | | | | |

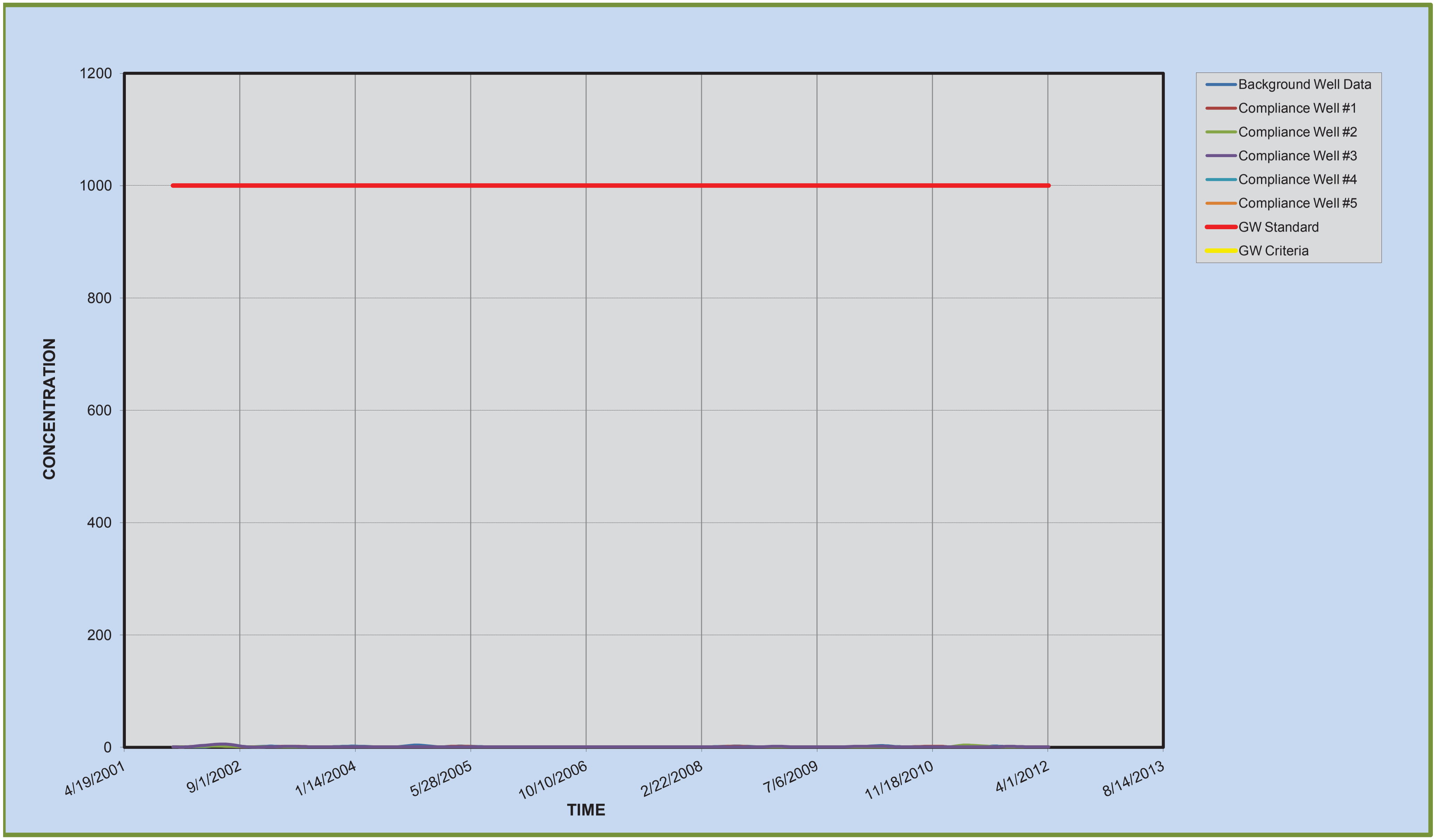
Results: Groundwater Standards/Criteria Comparison

| | Groundwater Standard | | Groundwater Criteria | | Total No. of Data Points |
|---|---|---|---|---|---|
| | No. Violations of GW Standard | % Violations of GW Standard | No. Violations of GW Criteria | % Violations of GW Criteria | |
| Background Well | 0 | 0% | | | 43 |
| Compliance Well #1 | 0 | 0% | | | 43 |
| Compliance Well #2 | 0 | 0% | | | 43 |
| Compliance Well #3 | 0 | 0% | | | 43 |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

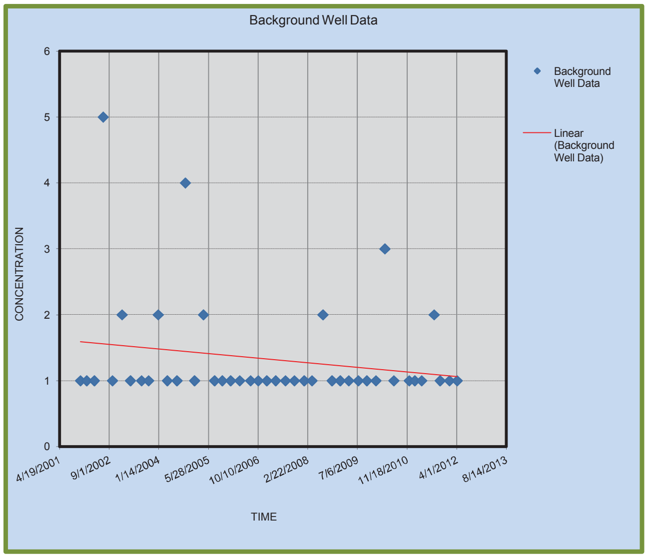
Results: Basic Statistics (less-than values ignored)

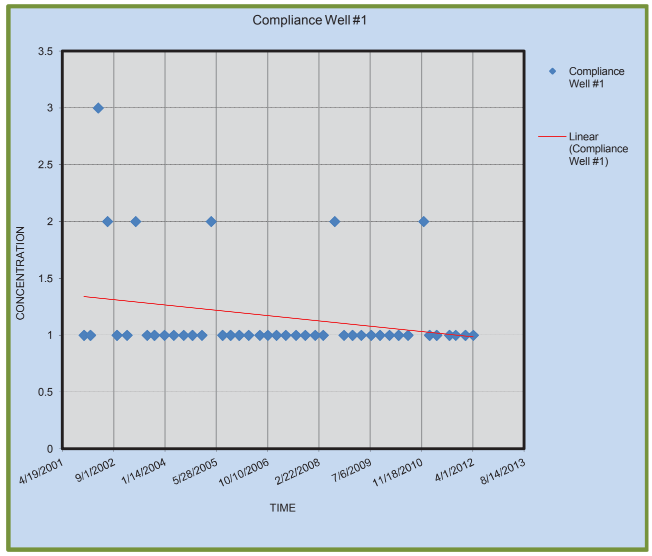
| | Maximum Value | Minimum Value | Average | | |
|---|---|---|---|---|---|
| Background Well | 5 | 1 | 1 | | |
| Compliance Well #1 | 3 | 1 | 1 | | |
| Compliance Well #2 | 4 | 1 | 1 | | |
| Compliance Well #3 | 6 | 1 | 1 | | |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

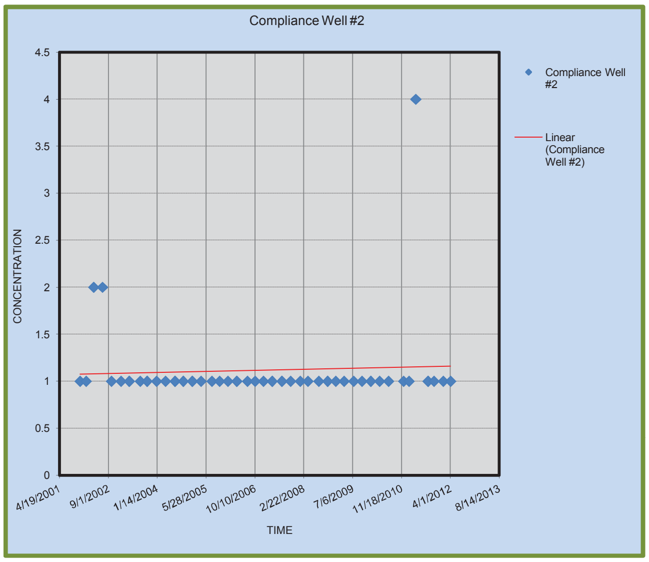
## Dominion-CPS: Groundwater Monitoring Data for Copper

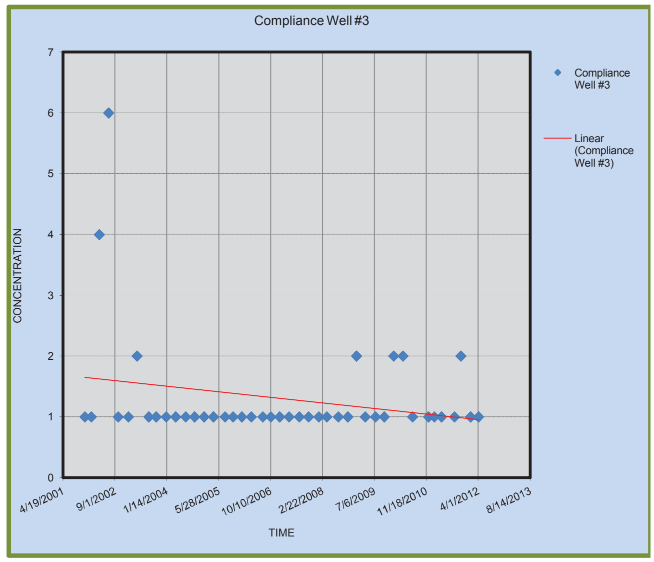


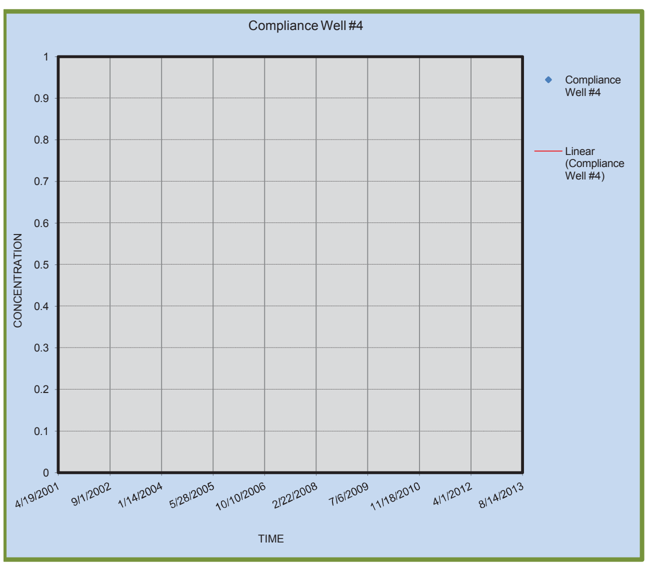
**Dominion-CPS: Groundwater Monitoring Regression Trends for Copper**

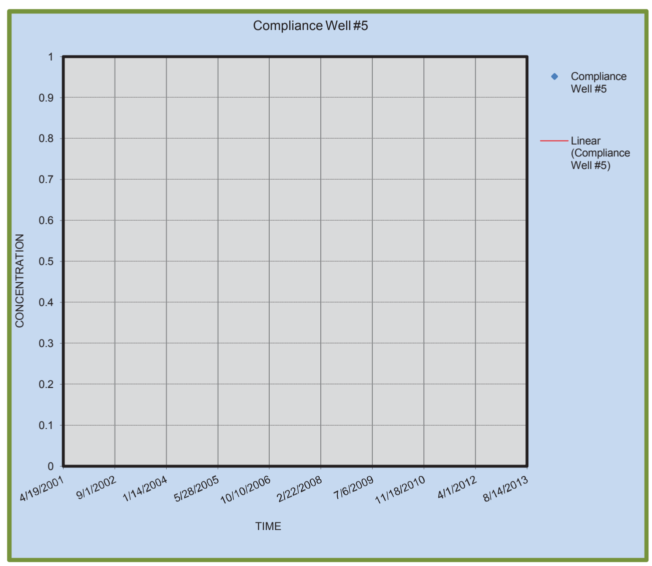


# Groundwater Monitoring Data Analysis (v.3)

| | |
|---|---|
| Facility Name: | Dominion- CPS |
| Permit No.: | VA0004146 |
| Monitoring Parameter: | Iron |
| Applicable GW Standard (if none leave blank): | |
| Applicable GW Criteria (if none leave blank): | 0.3 |
| Concentration Units (all data): | mg/L |

| | | Data Entry | | | | | |
|---|---|---|---|---|---|---|---|
| | Well Designation ? | B52 | MP-1 | MP-2 | MP-3 | | |
| | Sample or Report Date (ascending) | Background Well Data | Compliance Well #1 | Compliance Well #2 | Compliance Well #3 | Compliance Well #4 | Compliance Well #5 |
| 1 | 11/15/2001 | 0.71 | 0.05 | 3 | 0.25 | | |
| 2 | 1/16/2002 | 0.56 | 0.05 | 0.05 | 0.05 | | |
| 3 | 4/3/2002 | 0.24 | 0.05 | 0.05 | 0.05 | | |
| 4 | 7/2/2002 | 0.2 | 0.08 | 0.4 | 0.05 | | |
| 5 | 10/2/2002 | 0.05 | 0.05 | 0.16 | 0.05 | | |
| 6 | 1/8/2003 | 0.05 | 0.05 | 0.05 | 1.64 | | |
| 7 | 4/2/2003 | 0.05 | 0.05 | 0.05 | 1.37 | | |
| 8 | 7/23/2003 | 0.05 | 0.07 | 0.05 | 0.05 | | |
| 9 | 10/2/2003 | 0.05 | 0.05 | 0.28 | 0.06 | | |
| 10 | 1/7/2004 | 0.05 | 0.05 | 0.11 | 0.07 | | |
| 11 | 4/7/2004 | 0.05 | 0.05 | 1.57 | 0.28 | | |
| 12 | 7/13/2004 | 0.07 | 0.05 | 0.17 | 0.06 | | |
| 13 | 10/6/2004 | 0.05 | 0.05 | 0.05 | 0.05 | | |
| 14 | 1/6/2005 | 0.05 | 0.05 | 0.42 | 0.26 | | |
| 15 | 4/6/2005 | 0.05 | 0.05 | 0.06 | 0.05 | | |
| 16 | 7/27/2005 | 0.05 | 0.08 | 0.05 | 0.05 | | |
| 17 | 10/13/2005 | 0.05 | 0.05 | 0.05 | 0.05 | | |
| 18 | 1/5/2006 | 0.05 | 0.05 | 0.05 | 0.05 | | |
| 19 | 4/6/2006 | 0.05 | 0.05 | 0.05 | 0.05 | | |
| 20 | 7/25/2006 | 0.05 | 0.94 | 0.21 | 0.05 | | |
| 21 | 10/11/2006 | 0.08 | 0.05 | 0.05 | 0.05 | | |
| 22 | 1/4/2007 | 0.05 | 0.05 | 0.05 | 0.05 | | |
| 23 | 4/4/2007 | 0.05 | 0.05 | 0.05 | 0.05 | | |
| 24 | 7/12/2007 | 0.05 | 0.06 | 0.1 | 0.05 | | |
| 25 | 10/10/2007 | 0.05 | 0.05 | 0.09 | 0.09 | | |
| 26 | 1/16/2008 | 0.05 | 0.05 | 0.05 | 0.05 | | |
| 27 | 4/3/2008 | 0.07 | 0.05 | 0.05 | 0.05 | | |
| 28 | 7/23/2008 | 0.05 | 0.09 | 0.05 | 0.05 | | |
| 29 | 10/22/2008 | 0.1 | 0.09 | 0.18 | 0.05 | | |
| 30 | 1/13/2009 | 0.06 | 0.06 | 0.07 | 0.05 | | |
| 31 | 4/8/2009 | 0.08 | 0.05 | 0.05 | 0.05 | | |
| 32 | 7/15/2009 | 0.11 | 0.1 | 0.09 | 0.05 | | |
| 33 | 10/8/2009 | 0.05 | 0.09 | 0.05 | 0.05 | | |
| 34 | 1/7/2010 | 0.11 | 0.05 | 0.16 | 0.05 | | |
| 35 | 4/7/2010 | 0.05 | 0.05 | 0.05 | 0.05 | | |
| 36 | 7/7/2010 | 0.05 | 0.05 | 0.08 | 0.05 | | |
| 37 | 12/8/2010 | 0.05 | 0.05 | 2.26 | 0.42 | | |
| 38 | 2/3/2011 | 0.05 | 0.05 | 0.08 | 0.05 | | |
| 39 | 4/13/2011 | 0.05 | 0.05 | 0.07 | 0.05 | | |
| 40 | 8/16/2011 | 0.05 | 0.06 | 0.12 | 0.05 | | |
| 41 | 10/16/2011 | 0.05 | 0.05 | 0.06 | 0.05 | | |
| 42 | 1/18/2012 | 0.05 | 0.05 | 0.05 | 0.05 | | |
| 43 | 4/4/2012 | 0.05 | 0.05 | 0.1 | 0.11 | | |
| 44 | | | | | | | |
| 45 | | | | | | | |
| 46 | | | | | | | |
| 47 | | | | | | | |
| 48 | | | | | | | |
| 49 | | | | | | | |
| 50 | | | | | | | |

Results: Significance to Background

| | Distribution Tests | | Non-normal Test | Normal Tests | |
|---|---|---|---|---|---|
| | Shapiro-Wilk Normality Test | Shapiro-Wilk Log-Normality Test | Wilcoxon Rank Sum Test | T-test | T-test (lognormal) |
| Background Well | Not normal | Not normal | N/A | | |
| Compliance Well #1 | Not normal | Not normal | Not Significant | Not Significant | Not Significant |
| Compliance Well #2 | Not normal | Not normal | Not Significant | Significant | Significant |
| Compliance Well #3 | Not normal | Not normal | Not Significant | Not Significant | Not Significant |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

Results: Linear Regression Trend Analysis and Interpretation of Data

| | Regression Line Slope | Pearson Correlation (R) | Interpretation | |
|---|---|---|---|---|
| | | | Linear Trend | Degree of Data Linearity |
| Background Well | -4.64784E-05 | -0.416386407 | Slight Decrease | Moderately Weak |
| Compliance Well #1 | -1.5246E-06 | -0.012949427 | Slight Decrease | Very Weak |
| Compliance Well #2 | -8.7139E-05 | -0.170248244 | Slight Decrease | Very Weak |
| Compliance Well #3 | -7.75981E-05 | -0.283337328 | Slight Decrease | Moderately Weak |
| Compliance Well #4 | | | | |
| Compliance Well #5 | | | | |

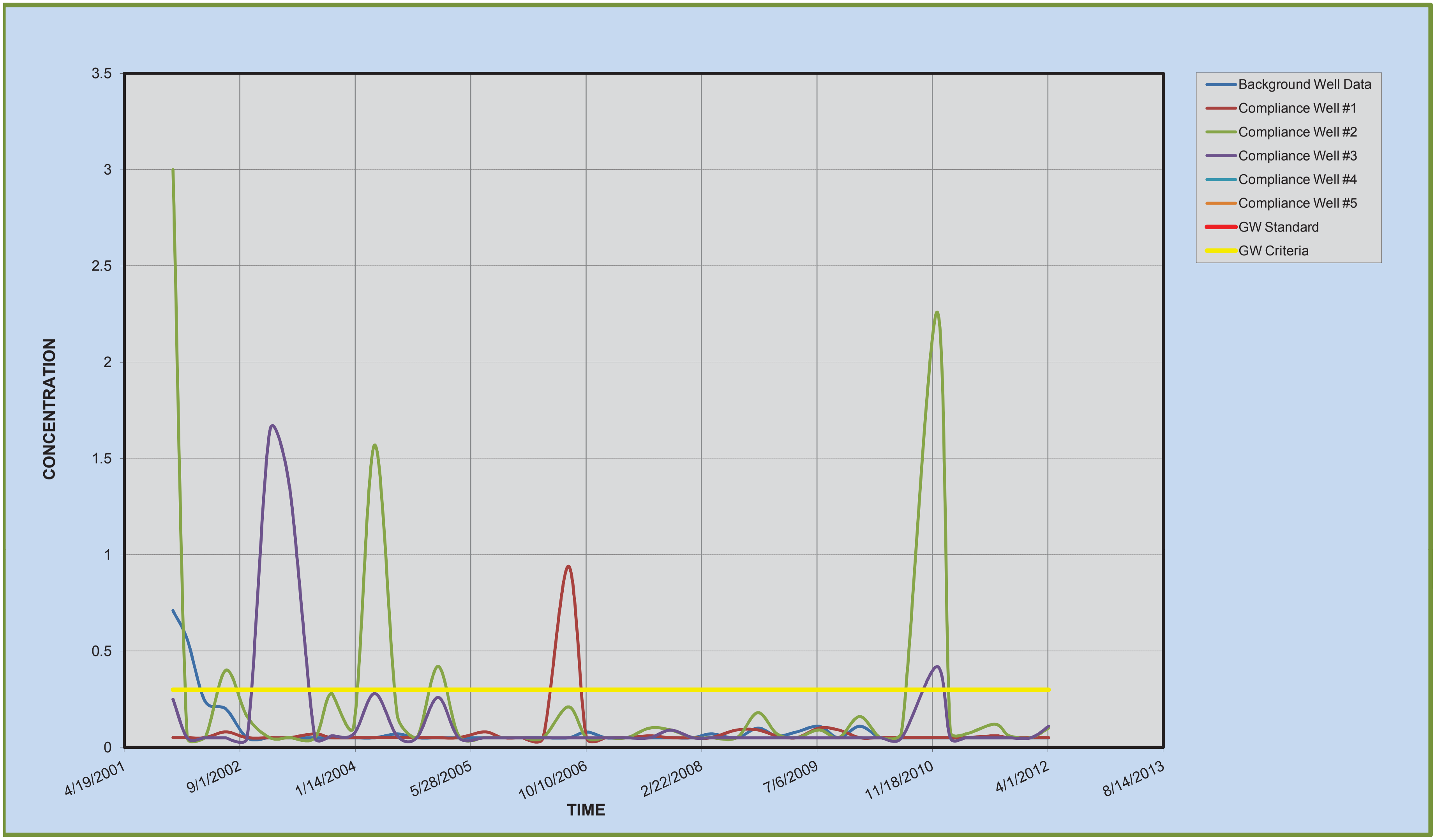
Results: Groundwater Standards/Criteria Comparison

| | Groundwater Standard | | Groundwater Criteria | | Total No. of Data Points |
|---|---|---|---|---|---|
| | No. Violations of GW Standard | % Violations of GW Standard | No. Violations of GW Criteria | % Violations of GW Criteria | |
| Background Well | | | 2 | 4.7% | 43 |
| Compliance Well #1 | | | 1 | 2.3% | 43 |
| Compliance Well #2 | | | 5 | 11.6% | 43 |
| Compliance Well #3 | | | 3 | 7% | 43 |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

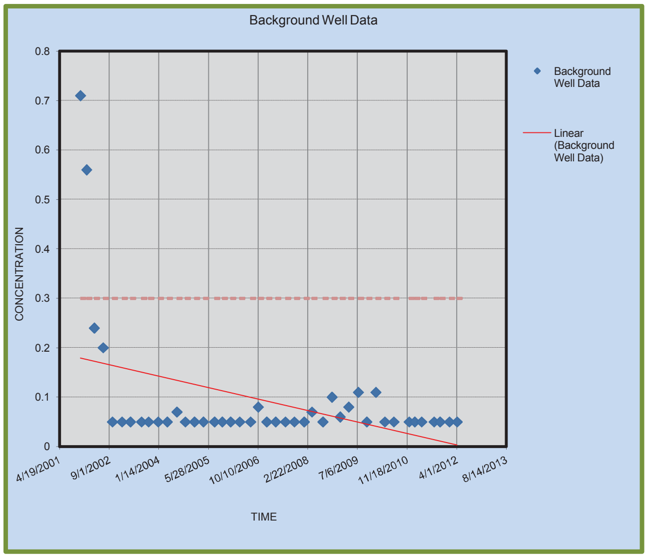
Results: Basic Statistics (less-than values ignored)

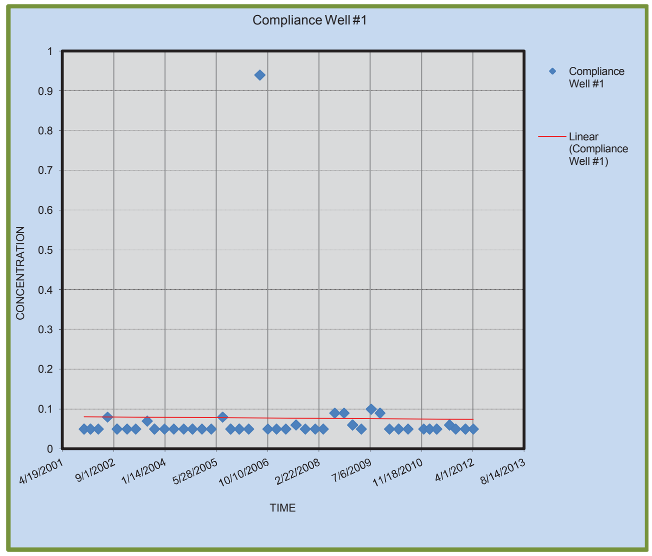
| | Maximum Value | Minimum Value | Average | | |
|---|---|---|---|---|---|
| Background Well | 1 | 0 | 0 | | |
| Compliance Well #1 | 1 | 0 | 0 | | |
| Compliance Well #2 | 3 | 0 | 0 | | |
| Compliance Well #3 | 2 | 0 | 0 | | |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

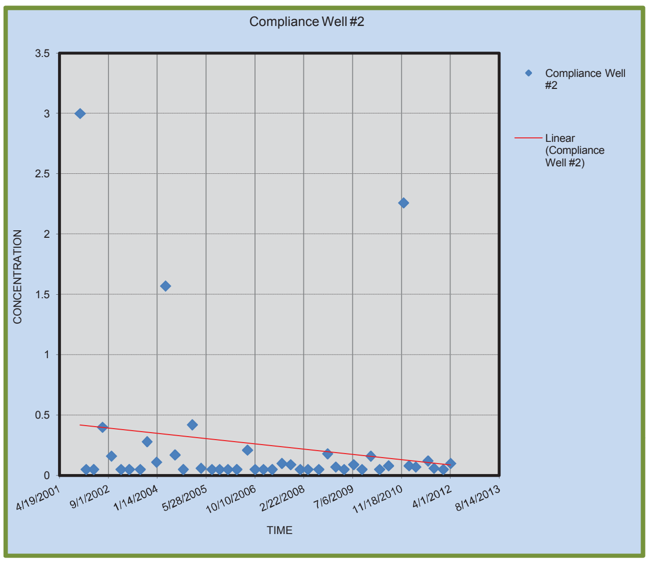
## Dominion- CPS: Groundwater Monitoring Data for Iron

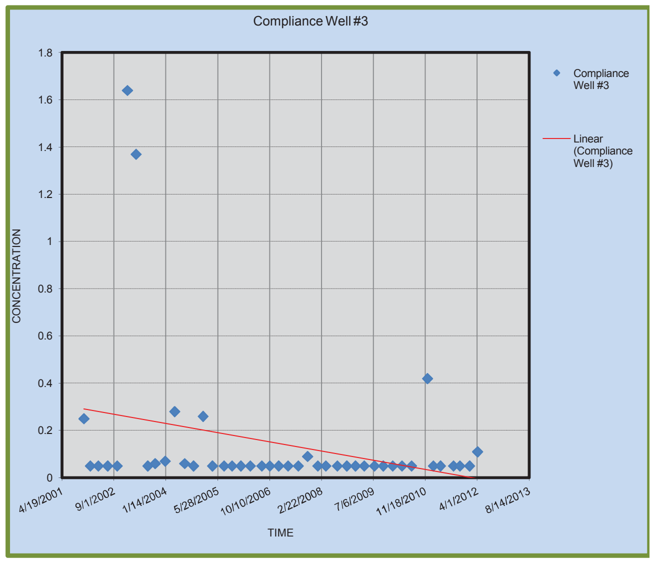


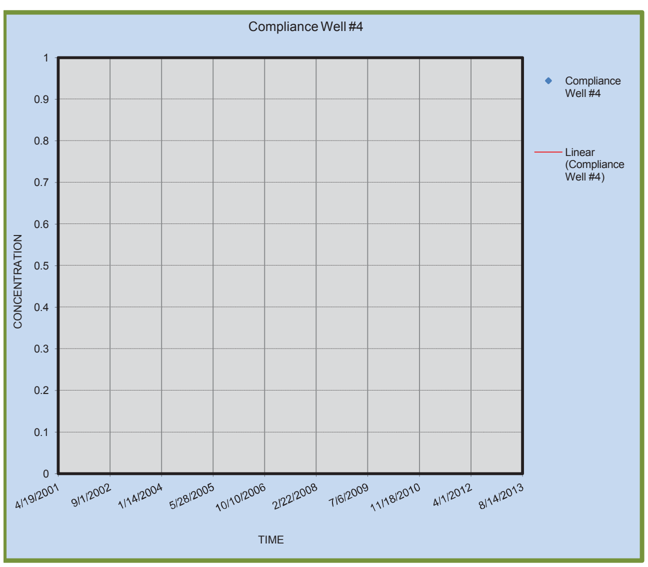
## Dominion- CPS: Groundwater Monitoring Regression Trends for Iron

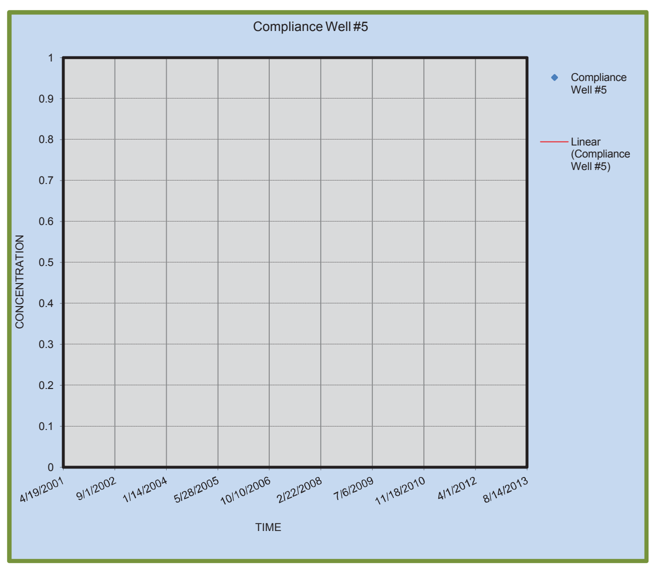


Groundwater Monitoring Data Analysis (v.3)

| | |
|---|---|
| Facility Name: | Dominion- CPS |
| Permit No.: | VA0004146 |
| Monitoring Parameter: | pH |
| Applicable GW Standard (if none leave blank): | 6.5-9 |
| Applicable GW Criteria (if none leave blank): | |
| Concentration Units (all data): | s.u. |

| | | Data Entry | | | | | |
|---|---|---|---|---|---|---|---|
| | Well Designation ? | B52 | MP-1 | MP-2 | MP-3 | | |
| | Sample or Report Date (ascending) | Background Well Data | Compliance Well #1 | Compliance Well #2 | Compliance Well #3 | Compliance Well #4 | Compliance Well #5 |
| 1 | 11/15/2001 | 5 | 6.63 | 5.82 | 5.39 | | |
| 2 | 1/16/2002 | 5.25 | 5.45 | 5.78 | 5.3 | | |
| 3 | 4/3/2002 | 5.64 | 5.83 | 5.9 | 5.31 | | |
| 4 | 7/2/2002 | 4.89 | 6.69 | 5.77 | 5.44 | | |
| 5 | 10/2/2002 | 4.52 | 5.18 | 5.37 | 5 | | |
| 6 | 1/8/2003 | 5.4 | 5.18 | 5.29 | 4.73 | | |
| 7 | 4/2/2003 | 5.29 | 5.8 | 6.1 | 5.46 | | |
| 8 | 7/23/2003 | 5.63 | 5.33 | 6.03 | 5.24 | | |
| 9 | 10/2/2003 | 5.49 | 5.62 | 5.63 | 4.66 | | |
| 10 | 1/7/2004 | 5.66 | 5.37 | 7.15 | 6.1 | | |
| 11 | 4/7/2004 | 5.57 | 5.25 | 6 | 5.12 | | |
| 12 | 7/13/2004 | 4.92 | 6.29 | 5.75 | 5.03 | | |
| 13 | 10/6/2004 | 4.88 | 5.27 | 5.9 | 5.62 | | |
| 14 | 1/6/2005 | 6.24 | 5.63 | 6.99 | 5.44 | | |
| 15 | 4/6/2005 | 5.63 | 6.01 | 6.14 | 5.02 | | |
| 16 | 7/27/2005 | 5.13 | 5.5 | 5.77 | 5.67 | | |
| 17 | 10/13/2005 | 5.54 | 6.08 | 5.86 | 5.87 | | |
| 18 | 1/5/2006 | 5.32 | 5.48 | 5.87 | 6 | | |
| 19 | 4/6/2006 | 5.15 | 5.83 | 6.11 | 5.15 | | |
| 20 | 7/25/2006 | 5.15 | 6.42 | 5.59 | 5 | | |
| 21 | 10/11/2006 | 5.54 | 5.51 | 5.61 | 5.15 | | |
| 22 | 1/4/2007 | 5.32 | 5.32 | 6.04 | 5.19 | | |
| 23 | 4/4/2007 | 5.32 | 6.2 | 6.01 | 5.53 | | |
| 24 | 7/12/2007 | 6.01 | 4.75 | 6.05 | 4.84 | | |
| 25 | 10/10/2007 | 5.25 | 5.56 | 5.67 | 5.33 | | |
| 26 | 1/16/2008 | 5.45 | 5.54 | 5.73 | 5.27 | | |
| 27 | 4/3/2008 | 5.6 | 5.56 | 6.01 | 5.23 | | |
| 28 | 7/23/2008 | 5.15 | 5.58 | 6.14 | 5.63 | | |
| 29 | 10/22/2008 | 5.57 | 5.7 | 6.04 | 5.64 | | |
| 30 | 1/13/2009 | 4.84 | 5.43 | 5.89 | 5.3 | | |
| 31 | 4/8/2009 | 5.44 | 5.75 | 5.89 | 5.59 | | |
| 32 | 7/15/2009 | 6.57 | 5.78 | 5.57 | 6.02 | | |
| 33 | 10/8/2009 | 5.47 | 5.48 | 6.32 | 5.7 | | |
| 34 | 1/7/2010 | 5.48 | 5.56 | 6.42 | 5.45 | | |
| 35 | 4/7/2010 | 6.05 | 5.37 | 5.75 | 5.58 | | |
| 36 | 7/7/2010 | 7.21 | 6.22 | 6.09 | 6.86 | | |
| 37 | 12/8/2010 | 5.1 | 5.61 | 5.71 | 5.2 | | |
| 38 | 2/3/2011 | 5.46 | 5.92 | 5.67 | 5.43 | | |
| 39 | 4/13/2011 | 4.93 | 6.44 | 6.35 | 5.07 | | |
| 40 | 8/16/2011 | 5.33 | 5.42 | 5.74 | 5.04 | | |
| 41 | 10/16/2011 | 4.93 | 5.19 | 5.94 | 5.44 | | |
| 42 | 1/18/2012 | 5.24 | 5.68 | 6.32 | 5.44 | | |
| 43 | 4/4/2012 | 5.46 | 6.66 | 6.08 | 5 | | |
| 44 | | | | | | | |
| 45 | | | | | | | |
| 46 | | | | | | | |
| 47 | | | | | | | |
| 48 | | | | | | | |
| 49 | | | | | | | |
| 50 | | | | | | | |

Results: Significance to Background

| | Distribution Tests | | Non-normal Test | Normal Tests | |
|---|---|---|---|---|---|
| | Shapiro-Wilk Normality Test | Shapiro-Wilk Log-Normality Test | Wilcoxon Rank Sum Test | T-test | T-test (lognormal) |
| Background Well | Not normal | Not normal | N/A | | |
| Compliance Well #1 | Not normal | Not normal | Not Significant | Significant | Significant |
| Compliance Well #2 | Not normal | Not normal | Not Significant | Significant | Significant |
| Compliance Well #3 | Not normal | Not normal | Not Significant | Not Significant | Not Significant |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

Results: Linear Regression Trend Analysis and Interpretation of Data

| | Regression Line Slope | Pearson Correlation (R) | Interpretation | |
|---|---|---|---|---|
| | | | Linear Trend | Degree of Data Linearity |
| Background Well | 7.7671E-05 | 0.188459742 | Slight Increase | Very Weak |
| Compliance Well #1 | 8.04976E-06 | 0.0210322 | Slight Increase | Very Weak |
| Compliance Well #2 | 3.46955E-05 | 0.113801926 | Slight Increase | Very Weak |
| Compliance Well #3 | 6.33353E-05 | 0.182411414 | Slight Increase | Very Weak |
| Compliance Well #4 | | | | |
| Compliance Well #5 | | | | |

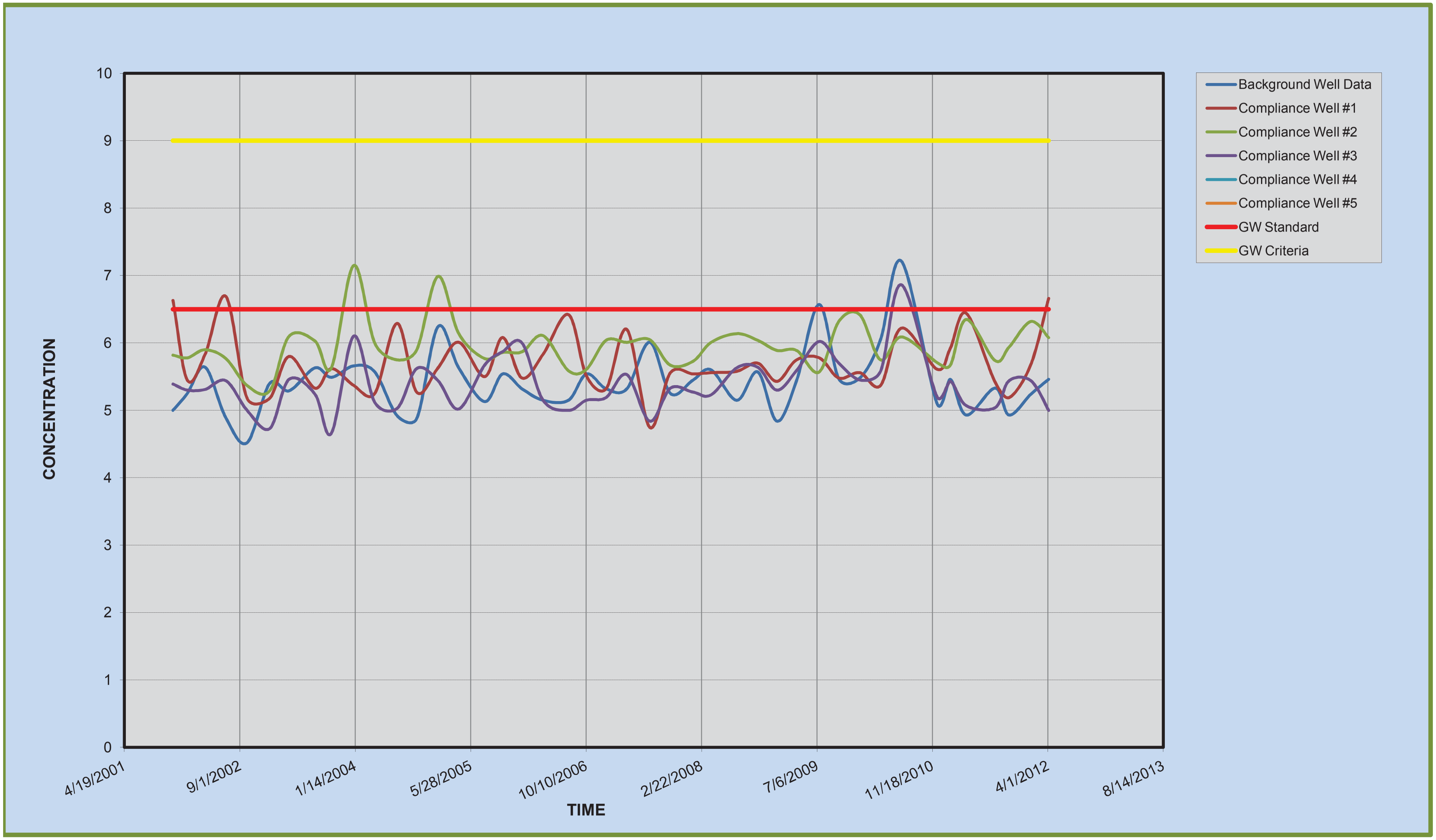
Results: Groundwater Standards/Criteria Comparison

| | Groundwater Standard | | Groundwater Criteria | | Total No. of Data Points |
|---|---|---|---|---|---|
| | No. Violations of GW Standard | % Violations of GW Standard | No. Violations of GW Criteria | % Violations of GW Criteria | |
| Background Well | 0 | 0% | | | 43 |
| Compliance Well #1 | 0 | 0% | | | 43 |
| Compliance Well #2 | 0 | 0% | | | 43 |
| Compliance Well #3 | 0 | 0% | | | 43 |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

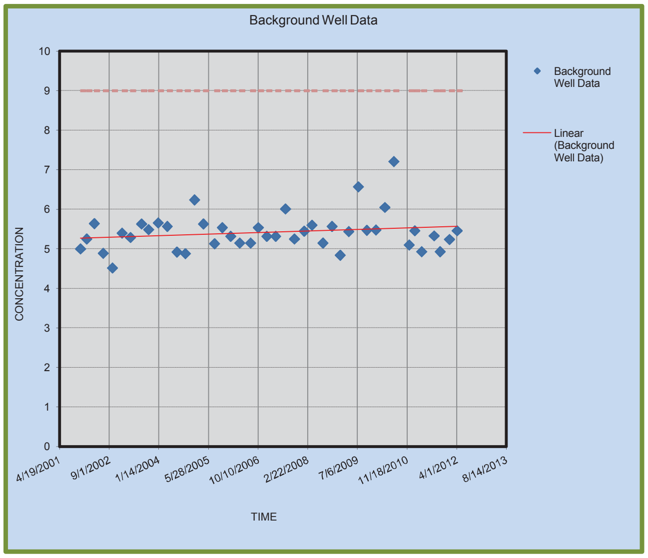
Results: Basic Statistics (less-than values ignored)

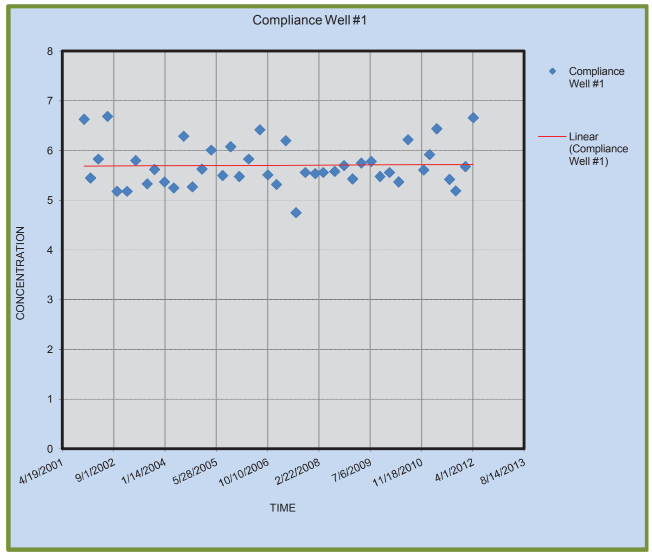
| | Maximum Value | Minimum Value | Average | | |
|---|---|---|---|---|---|
| Background Well | 7 | 5 | 5 | | |
| Compliance Well #1 | 7 | 5 | 6 | | |
| Compliance Well #2 | 7 | 5 | 6 | | |
| Compliance Well #3 | 7 | 5 | 5 | | |
| Compliance Well #4 | | | | | |
| Compliance Well #5 | | | | | |

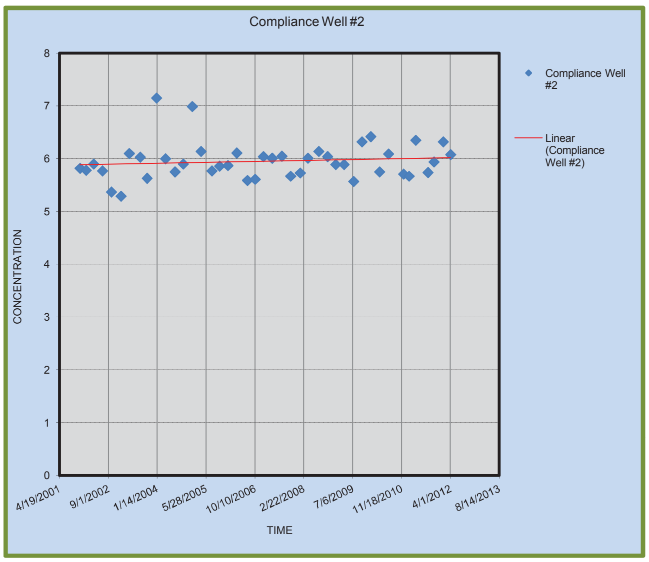
Dominion- CPS: Groundwater Monitoring Data for pH

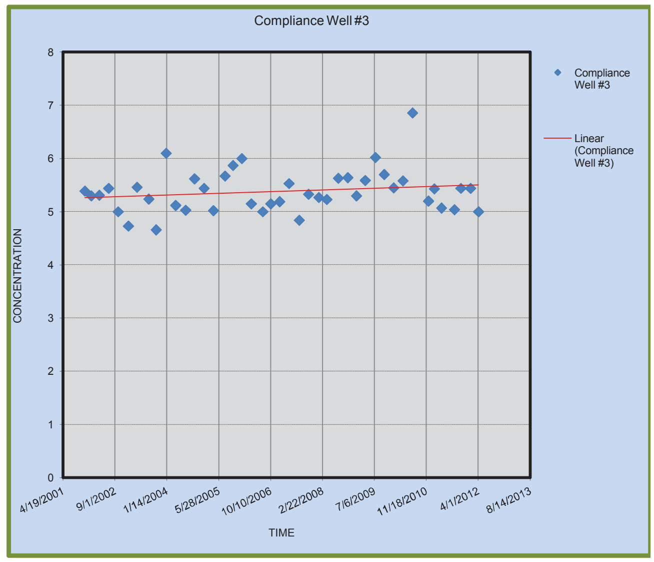


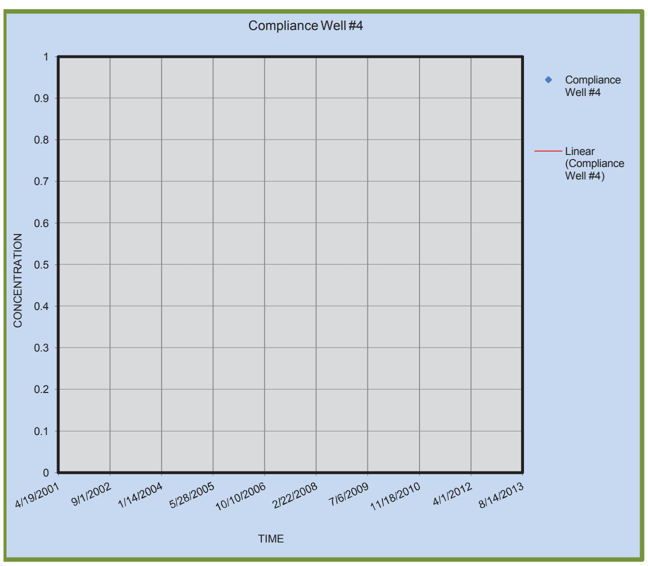
## Dominion- CPS: Groundwater Monitoring Regression Trends for pH

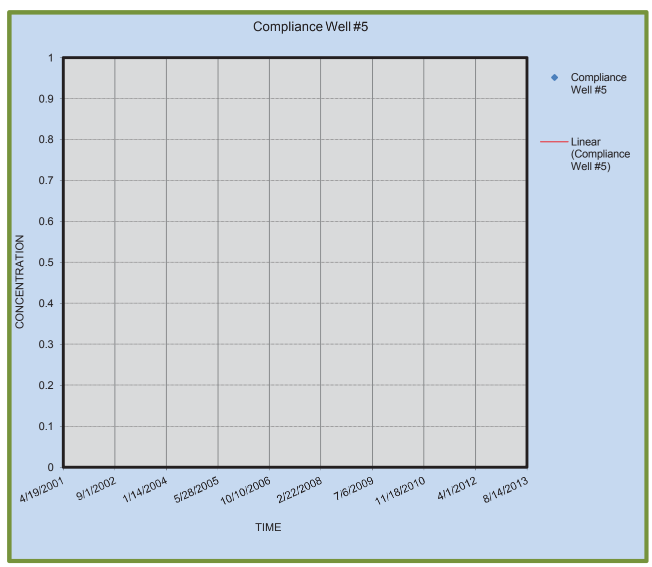


**Attachment 9**

Discussion of WET Testing

**MEMORANDUM**

**DEPARTMENT OF ENVIRONMENTAL QUALITY**
***Piedmont Regional Office***

**4949-A Cox Road** **Glen Allen, VA 23060** **804/527-5020**

**SUBJECT**: Dominion Virginia Power – Chesterfield Power Station
Review of Whole Effluent Toxicity Testing Data

**TO**: Deborah DeBiasi – Toxics Program Manager, OWP&CA

**FROM**: Emilee Adamson – PRO

**DATE**: August 20, 2012

**COPIES**: File

Facility Description

The Chesterfield Power Station generates electricity using steam produced by the combustion of coal, natural gas and fuel oil. The Station has a generating capacity of 1750 megawatts (maximum dependable capacity of 1631 megawatts in the summer and 1731 megawatts in the winter).

Outfalls 001, 002 and 003 are all non-contact cooling water discharges of 212 MGD, 89 MGD and 757 MGD, respectively (30 day average maximums as reflected in the DMR data summary). Outfalls 001 and 002 discharge to the main stem of the James River. Outfall 003 discharges to the head of Farrar Gut.

Outfall 004 is the discharge from the old ash pond to the head of Farrar Gut. The 30-day average max flow is 15.3 MGD (as reflected in the DMR data summary).

Outfall 005 is the discharge from the new ash pond or (Upper (East) Ash Pond) to Farrar Gut at a point approximately 0.4 mile upstream from Farrar Gut's confluence with the James River. The average of the 30-day maximum flows is 4.83 (as reflected in the DMR data summary). This statistic is used instead of the maximum 30 day average because it is the greater value and supports a more conservative evaluation. The new ash pond is used to dispose of dewatered ash from the old ash pond. The use of the new pond is addressed in the "Revised Closure Plan, Upper (East) Ash Pond, Chesterfield Power Station, Chesterfield County, Virginia" dated September 2003 and approved by the staff of the DEQ by letter dated September 12, 2003. The discharge at Outfall 005 consists of runoff from the disposed ash after treatment in a large sedimentation pond that was constructed at the eastern end of the pond.

There is also an internal intermittent discharge from a metals treatment pond – Outfall 104 – to the old ash pond. That discharge is limited in accordance with the steam electric power guidelines for metals cleaning wastes. The 30-day average maximum flow is 3.23 MGD (as reflected in the DMR data summary).

TMP Requirements in the Existing Permit

The permit was reissued December 10, 2004.

The permit requires annual acute and chronic toxicity testing using Ceriodaphnia dubia at Outfalls 001, 002, and 003. A 24-hour flow proportioned composite sample is required at Outfalls 001 through 003.

A chronic toxicity permit limitation was assigned to Outfall 004 in the 2004 reissuance. The limit was assigned with a compliance schedule of four years. Consequently, annual acute and chronic toxicity testing were required until the limitation became effective. The limitation became effective in December of 2008. Quarterly monitoring and reporting of chronic toxicity to demonstrate compliance with the permit limitation began in January of 2009. Consequently, the annual acute toxicity test for 2009 was not required. The chronic limitation is considered protective of both acute and chronic toxicity.

The permit also requires that four sets of toxicity tests, at least 30 days apart, be conducted at Outfall 005. Acute and chronic testing with *Ceriodaphnia dubia* and *Pimephales promelas* was required using grab samples. Chronic tests are required only if discharge occurs over five consecutive days.

Data Summary

Attached are summary sheets for each outfall, outlining the 2004 permit cycle data. The IWCs for the chronic testing in the existing permit are stated at the top of the summary sheets for each outfall.

All annual testing met the appropriate criteria.

The IWCs in the permit to be reissued are as follows:

1. For discharges to the main channel of the James River – Outfalls 001 and 002 – the tidal defaults of 2 to 1 dilution for acute effects and 50 to 1 for chronic effects are used. The defaults result in a required acute endpoint of NOAEC = 100% and a chronic endpoint of NOEC = 17%. These values were generated using WETLIM10 (attached).

2. The IWC for Outfall 003 is 100%. Farrar Gut would have a small, tidally fluctuating flow without the discharges from Virginia Power. Given the large volume of discharge at Outfall 003, an IWC of 100% is appropriate, thus a chronic endpoint of NOEC greater than or equal to 69% is proposed. This approach is consistent with the approach used to develop effluent limitations in the permit. The required acute endpoint is NOAEC = 100%. The endpoints were generated using WETLIM10 (attached).

3. Outfall 004, which discharges to Farrar Gut was modeled as a discharge to a free-flowing receiving stream consisting of the $10^{th}$ percentile of 30 day average flows from Outfall 003 (511 MGD). The modeling is consistent with the approach used to develop effluent limitations in the permit. However, the toxicity analysis is not consistent with the effluent limitation approach in that Outfalls 004 and 005 are evaluated separately rather than as a single discharge. Separate evaluation of Outfalls 004 and 005 began in the 2004 permit in response to Virginia Power's request. It was considered appropriate to address the outfalls individually given the need for a WET limitation on Outfall 004. WETLIM10 was used to calculate the WLAs for Outfall 004. The resultant WLAs were entered in the STATS.exe program along with data generated during the 2004 permit cycle for chronic toxicity (Attachment 4). STATS.exe determined reasonable potential does not exist for the discharge to exceed the WLA; and, therefore, a limitation is not needed. Because of antibacksliding the 2004 limitation will be carried forward in this reissuance. Grab sampling is assigned for this limitation in accordance with EPA Form 2C, which allows grab samples to be used for "holding ponds or other impoundments with a retention period greater than 24 hours."

4. As described above, Outfall 005 also discharges to Farrar Gut and was modeled as a discharge to a free-flowing stream consisting of the 10th percentile of 30 day average flows from Outfall 003 (511 MGD). WETLIM10 was used to calculate the test endpoints for Outfall 005, which generated the following required endpoints: an acute endpoint of $LC_{50}$ = 7% and a chronic endpoint of NOEC = 1%. These endpoints are assigned to Outfall 005 in this permit reissuance. Grab sampling is assigned for this limitation in accordance with EPA Form 2C, which allows grab samples to be used for “holding ponds or other impoundments with a retention period greater than 24 hours.”

Conclusions and Recommendations

Outfalls 001, 002, 003 and 005 successfully met the decision criteria for acute and chronic toxicity. Annual acute and chronic testing as prescribed in the 2004 permit shall continue in the permit being reissued.

A maximum chronic WET limitation of 50 toxicity units became effective in December 2008 and quarterly monitoring began in January, 2009. The first three quarters of test results have demonstrated compliance with the limitation. Although the analysis for this reissuance does not indicate the need for a limitation, antibacksliding prohibits removal of the limitation. Therefore, the maximum chronic toxicity limitation for Outfall 004 of 50 TUc will be carried forward in this reissuance.

The proposed permit language is as follows (the reporting dates are consistent with the current permit):

Whole Effluent Toxicity (WET) Testing Program

a. Outfalls 001, 002, and 003:

(1) In accordance with the schedule in I.X.d below, the permittee shall perform annual toxicity testing on Outfalls 001, 002, and 003 using flow-proportioned composite samples for the duration of the permit.

The acute test to use is:
48 Hour Static Acute test using *Ceriodaphnia dubia*

These acute tests shall be conducted using 5 geometric dilutions of effluent with a minimum of 4 replicates, with 5 organisms in each. The NOAEC (No Observed Adverse Effect Concentration), as determined by hypothesis testing, shall be reported on the DMR. The $LC_{50}$ should also be determined and noted on the submitted report. Tests in which the control survival is less than 90% are not acceptable.

The chronic test to use is:
Chronic 3-Brood Survival and Reproduction Static Renewal Test using *Ceriodaphnia dubia*

These chronic tests shall be conducted in such a manner and at sufficient dilutions (minimum of five dilutions, derived geometrically) to determine the "No Observed Effect Concentration" (NOEC) for survival and reproduction. Results which cannot be quantified (i.e., a “less than” NOEC value) are not acceptable, and a retest will have to be performed. A retest of a non-acceptable test must be performed during the same compliance period as the test it is replacing. Express the test NOEC as $TU_c$ (Chronic Toxicity Units), by dividing 100/NOEC. The $LC_{50}$ at 48 hours and the $IC_{25}$ shall also be reported.

The permittee may provide additional samples to address data variability; these data shall be reported and may be included in the evaluation of effluent toxicity. Test procedures and reporting shall be in accordance with the WET testing methods cited in 40 CFR 136.3.

(2) The test dilutions shall be able to determine compliance with the following endpoints:

(a) Acute tests:

| | |
|---|---|
| Outfall 001 | NOAEC = 100% effluent |
| Outfall 002 | NOAEC = 100% effluent |
| Outfall 003 | NOAEC = 100% effluent |

(b) Chronic tests:

| | |
|---|---|
| Outfall 001 | NOEC $\geq$ 17% effluent equivalent to a $TU_c$ of 5.9 |
| Outfall 002 | NOEC $\geq$ 17% effluent equivalent to a $TU_c$ of 5.9 |
| Outfall 003 | NOEC $\geq$ 69% effluent equivalent to a $TU_c$ of 1.44 |

(3) The test data for each outfall will be evaluated statistically by DEQ for reasonable potential at the conclusion of the test period. The data may be evaluated sooner if requested by the permittee, or if toxicity has been noted. Should DEQ evaluation of the data indicate that a limit is needed, the permit may be modified or, alternatively, revoked and reissued to include a WET limit and compliance schedule for that outfall. Following written notification from DEQ of the need for including a WET limitation, the toxicity tests of Part I.X. a.(1) for that outfall may be discontinued. The permit may be modified or revoked and reissued to include pollutant specific limits in lieu of a WET limit should it be demonstrated that toxicity is due to specific parameters. The pollutant specific limits must control the toxicity of the effluent.

b. Outfall 004 – Chronic WET Limit Testing:

(1) The chronic tests required in Part I.A.4 of this permit to meet the limit of an NOEC = 2%, equivalent to $TU_c$ of 50 shall be Chronic 3-Brood Static Renewal Survival and Reproduction Tests using *Ceriodaphnia dubia* conducted in such a manner and at sufficient dilutions (minimum of five dilutions, derived geometrically) to determine the "No Observed Effect Concentration" (NOEC) for survival and reproduction. The test endpoint (limit) shall be represented by a dilution, and if other than 100%, shall be bracketed by at least one dilution above and one dilution below it. Results which cannot be determined (i.e., a “less than” NOEC value) are not acceptable, and a retest shall be performed. A retest of a non-acceptable test must be performed during the same compliance period as the test it is replacing. For reporting on the Discharge Monitoring Report (DMR), the NOEC is to be expressed in Chronic Toxicity Units ($TU_C$), which is obtained by dividing 100 by the test NOEC. The $LC_{50}$ at 48 hours and the $IC_{25}$ shall also be reported.

(2) One copy of the toxicity test report shall be submitted to the Piedmont Regional Office in hard copy or by email concurrent with the Discharge Monitoring Report (DMR) on which the test result is reported. Test procedures and reporting shall be in accordance with the WET testing methods cited in 40 CFR 136.3.

(3) The permit may be modified or revoked and reissued to include pollutant specific limits in lieu of a WET limit should it be demonstrated that toxicity is due to specific parameters. The pollutant specific limits must control the toxicity of the effluent.

(4) Frequency of Testing
Quarterly testing is required as indicated in Part I.A.4 of this permit, beginning in the calendar quarter following the effective date of this permit.

c. Outfall 005:

(1) In accordance with the schedule in I.X.d below, the permittee shall perform acute and chronic toxicity tests of final effluent at Outfall 005. Grab samples shall be collected each time a discharge occurs, but at least 30 days apart, until four data sets have been collected. Chronic tests are required only if discharge occurs over five consecutive days.
The acute tests shall be:

48 Hour Static Acute test using *Ceriodaphnia dubia*
48 Hour Static Acute test using *Pimephales promelas*

These acute tests shall be performed with a minimum of 5 dilutions, derived geometrically, for calculation of a valid $LC_{50}$.

The chronic tests shall be:

Chronic 3-Brood Survival and Reproduction Static Renewal Test using *Ceriodaphnia dubia*
Chronic 7-day Survival and Growth Static Renewal test using *Pimephales promelas*

These chronic tests shall be conducted in such a manner and at sufficient dilutions (minimum of five dilutions, derived geometrically) to determine the "No Observed Effect Concentration" (NOEC) for survival and reproduction or growth. The $LC_{50}$ at 48 hours and the $IC_{25}$ shall also be reported. Results which cannot be quantified (i.e., a “less than” NOEC value) are not acceptable, and a retest shall be performed. The retest of a nonacceptable test shall be performed during the same compliance period as the test it is replacing. Express the test $LC_{50}$ as $TU_a$ (Acute Toxicity Units), by dividing $100/LC_{50}$. Express the test NOEC as $TU_c$ (Chronic Toxicity Units), by dividing 100/NOEC. The $LC_{50}$ at 48 hours and the $IC_{25}$ shall also be reported.

(2) The test dilutions shall be able to determine compliance with the following endpoints:

(a) Acute tests: **$LC_{50}$ $\geq$ 7%** effluent, equivalent to a $TU_a$ of = 14.28.

(b) Chronic tests: **NOEC $\geq$ 1%** effluent, equivalent to a $TU_c$ of =100

(3) The permittee may provide additional samples to address data variability. These data shall be reported and may be included in the evaluation of effluent toxicity. Test procedures and reporting shall be in accordance with the WET testing methods cited in 40 CFR 136.3

(4) The test data will be evaluated statistically by DEQ for reasonable potential at the conclusion of the test period. The data may be evaluated sooner if requested by the permittee, or if toxicity has been noted. Should DEQ evaluation of the data indicate that a limit is needed, the permit may be modified or, alternatively, revoked and

reissued to include a WET limit and compliance schedule. Following written notification from DEQ of the need for including a WET limitation, the toxicity tests of Part I.X. a.(1) may be discontinued. The permit may be modified or revoked and reissued to include pollutant specific limits should it be demonstrated that toxicity is due to specific parameters. The pollutant specific limits must control the toxicity of the effluent.

If evaluation of the data indicates that a limitation is not needed, annual acute and chronic testing shall commence in accordance with the remaining schedule in I.X.d below.

d. Reporting Schedule:

The permittee shall report the results of the toxicity testing on Outfalls 001, 002, 003 and 005 as appropriate, and supply to the Piedmont Regional Office one copy of the toxicity test reports specified in this WET Monitoring Program in accordance with the following schedule:

| Compliance Period | DMR/Report Due Date |
|---|---|
| By TBD | By TBD |
| By TBD | By TBD |
| By TBD | By TBD |
| By TBD | By TBD |
| By TBD | By TBD |

Reporting for the Outfall 004 WET limitation shall be conducted quarterly and reported on the DMR as required in Part I.A.4 of this permit. One copy of the toxicity test report associated with each test, shall be submitted in hard copy or by email concurrent with the Discharge Monitoring Report (DMR) on which the test result is reported, in accordance with Part I.X.b.(2), above.

**Sub-attachment 1**

VPDES Permit VA0004146 – Dominion Chesterfield Power Station (**Outfall 001**)

Permit endpoints: $LC_{50} \geq 50\%$
NOEC $\geq 2\%$

Results of acute toxicity tests during term of current permit:

| TEST DATE | *Ceriodaphnia dubia* | | Laboratory |
|---|---|---|---|
| | $LC_{50}$ | PERCENT SURVIVAL IN 100% EFFLUENT | |
| February 2005 | >100 | 100 | Coastal Bioanalysts |
| June 2005 | >100 | 100 | Coastal Bioanalysts |
| June 2006 | >100 | 100 | Coastal Bioanalysts |
| January 2008 | >100 | 95 | Coastal Bioanalysts |
| July 2008 | >100 | 100 | Coastal Bioanalysts |
| February 2010 | >100 | 100 | Coastal Bioanalysts |
| April 2011 | >100 | 90 | Coastal Bioanalysts |
| March 2012 | >100 | 100 | Coastal Bioanalysts |

Results of chronic toxicity tests during term of current permit:

| TEST DATE** | *Ceriodaphnia dubia* | | Laboratory |
|---|---|---|---|
| | Survival | Reproduction | |
| February 2005 | 100 | 100 | Coastal Bioanalysts |
| June 2005 | 100 | 100 | Coastal Bioanalysts |
| June 2006 | 100 | 100 | Coastal Bioanalysts |
| January 2008 | 100 | 100 | Coastal Bioanalysts |
| July 2008 | 100 | 100 | Coastal Bioanalysts |
| February 2010 | 100 | 100 | Coastal Bioanalysts |
| April 2011 | 100 | 100 | Coastal Bioanalysts |
| March 2012 | 100 | 100 | Coastal Bioanalysts |

<u>Discussion</u>

Acute toxicity is not indicated.

Chronic toxicity is not indicated.

The proposed permit requires the continuation of annual acute and chronic WET testing with *Ceriodaphnia dubia.* The results of those tests will be evaluated for reasonable potential at the conclusion of the permit term or sooner if toxicity is noted and appropriate effluent limitations established.

**Sub-attachment 2**

VPDES Permit VA0004146 – Dominion Chesterfield Power Station (**Outfall 002**)

Permit endpoints: $LC_{50} \geq 50\%$
$NOEC \geq 2\%$

Results of acute toxicity tests during term of current permit:

| **TEST DATE** | ***Ceriodaphnia dubia*** | | **Laboratory** |
|---|---|---|---|
| | $LC_{50}$ | PERCENT SURVIVAL IN 100% EFFLUENT | |
| February 2005 | >100 | 100 | Coastal Bioanalysts |
| June 2005 | >100 | 95 | Coastal Bioanalysts |
| June 2006 | >100 | 95 | Coastal Bioanalysts |
| January 2008 | >100 | 80 | Coastal Bioanalysts |
| July 2008 | >100 | 100 | Coastal Bioanalysts |
| February 2010 | >100 | 95 | Coastal Bioanalysts |
| April 2011 | >100 | 95 | Coastal Bioanalysts |
| June 2012 | >100 | 100 | Coastal Bioanalysts |

Results of chronic toxicity tests during term of current permit:

| **TEST DATE**** | **NOEC- *Ceriodaphnia dubia*** | | **Laboratory** |
|---|---|---|---|
| | Survival | Reproduction | |
| February 2005 | 100 | 100 | Coastal Bioanalysts |
| June 2005 | 100 | 100 | Coastal Bioanalysts |
| June 2006 | 100 | 100 | Coastal Bioanalysts |
| January 2008 | 100 | 100 | Coastal Bioanalysts |
| July 2008 | 100 | 100 | Coastal Bioanalysts |
| February 2010 | 100 | 100 | Coastal Bioanalysts |
| April 2011 | 100 | 100 | Coastal Bioanalysts |
| June 2012 | 100 | 100 | Coastal Bioanalysts |

Discussion

Acute toxicity is not indicated.

Chronic toxicity is not indicated.

The proposed permit requires the continuation of annual acute and chronic WET testing with *Ceriodaphnia dubia.* The results of those tests will be evaluated for reasonable potential at the conclusion of the permit term, or sooner if toxicity is noted, and appropriate effluent limitations established.

**Sub-attachment 3**

VPDES Permit VA0004146 – Dominion Chesterfield Power Station (**Outfall 003**)

Permit endpoints: $LC_{50} \geq 100\%$
NOEC $\geq$ 100%

Results of acute toxicity tests during term of current permit:

| TEST DATE | *Ceriodaphnia dubia* | | Laboratory |
|---|---|---|---|
| | $LC_{50}$ | PERCENT SURVIVAL IN 100% EFFLUENT | |
| February 2005 | >100 | 100 | Coastal Bioanalysts |
| June 2005 | >100 | 100 | Coastal Bioanalysts |
| June 2006 | >100 | 100 | Coastal Bioanalysts |
| January 2008 | >100 | 95 | Coastal Bioanalysts |
| July 2008 | >100 | 100 | Coastal Bioanalysts |
| February 2010 | >100 | 100 | Coastal Bioanalysts |
| April 2011 | >100 | 100 | Coastal Bioanalysts |
| March 2012 | >100 | 100 | Coastal Bioanalysts |

Results of chronic toxicity tests during term of current permit:

| TEST DATE** | NOEC- *Ceriodaphnia dubia* | | Laboratory |
|---|---|---|---|
| | Survival | Reproduction | |
| February 2005 | 100 | 100 | Coastal Bioanalysts |
| June 2005 | 100 | 100 | Coastal Bioanalysts |
| June 2006 | 100 | 100 | Coastal Bioanalysts |
| January 2008 | 100 | 100 | Coastal Bioanalysts |
| July 2008 | 100 | 100 | Coastal Bioanalysts |
| February 2010 | 100 | 100 | Coastal Bioanalysts |
| April 2011 | 100 | 100 | Coastal Bioanalysts |
| March 2012 | 100 | 100 | Coastal Bioanalysts |

Discussion

Acute toxicity is not indicated.

Chronic toxicity is not indicated.

The proposed permit requires the continuation of annual acute and chronic WET testing with *Ceriodaphnia dubia.* The results of those tests will be evaluated for reasonable potential at the conclusion of the permit term, or sooner if toxicity is noted, and appropriate effluent limitations established.

**Sub-attachment 4**

VPDES Permit VA0004146 – Dominion Chesterfield Power Station (**Outfall 004**)

Permit endpoints: $LC_{50} \geq 13\%$
NOEC $\geq$ 2%

Results of acute toxicity tests during term of current permit:

| TEST DATE | *Ceriodaphnia dubia* | | Laboratory |
|---|---|---|---|
| | $LC_{50}$ | PERCENT SURVIVAL IN 100% EFFLUENT | |
| February 2005 | >37 | NR | Coastal Bioanalysts |
| June 2005 | >37 | NR | Coastal Bioanalysts |
| June 2006 | >100 | 100 | Coastal Bioanalysts |
| January 2008 | >100 | 90 | Coastal Bioanalysts |
| July 2008 | NR | NR | Coastal Bioanalysts |

Results of chronic toxicity tests during term of current permit:

| TEST DATE | NOEC *Ceriodaphnia dubia* | | Laboratory |
|---|---|---|---|
| | Survival | Reproduction | |
| April 2005 | 100 | 4 | Coastal Bioanalysts |
| August 2005 | 100 | 32 | Coastal Bioanalysts |
| June 2006 | 100 | 32 | Coastal Bioanalysts |
| January 2008 | 100 | 100 | Coastal Bioanalysts |
| July 2008 | 100 | 32 | Coastal Bioanalysts |
| February 2009 | 100 | 100 | Coastal Bioanalysts |
| May 2009 | 100 | 32 | Coastal Bioanalysts |
| August 2009 | 100 | 32 | Coastal Bioanalysts |

Discussion

Acute toxicity is not indicated.
In the February and June 2005 tests, the acute test ratios did not include 100% effluent; consequently, survival in 100% effluent cannot be reported.

Chronic toxicity is not indicated.

A WET limitation was assigned to Outfall 004 in the 2004 permit reissuance. The permittee was allowed a four year schedule of compliance before the limitation became effective. The limitation was effective as of Dec. 10, 2008. Monitoring began in January and reporting on a quarterly basis followed. The results received to date indicate compliance with the limitation.

**Attachment 5**

VPDES Permit VA0004146 – Dominion Chesterfield Power Station (**Outfall 005**)

Permit endpoints: $LC_{50} \geq$ 10% effluent
NOEC $\geq$ 1% effluent

Results of acute toxicity tests during term of current permit:

| **TEST DATE** | ***Ceriodaphnia dubia*** | | ***Pimephales promelas*** | | **Laboratory** |
|---|---|---|---|---|---|
| | $LC_{50}$ | PERCENT SURVIVAL IN 100% EFFLUENT | $LC_{50}$ | PERCENT SURVIVAL IN 100% EFFLUENT | |
| August 2004 | >100 | 100 | >100 | 95 | Coastal Bioanalysts |
| October 2004 | >100 | 100 | >100 | 100 | Coastal Bioanalysts |
| May 2005 | >100 | 100 | >100 | 100 | Coastal Bioanalysts |
| February 2006 | >100 | 100 | >100 | 100 | Coastal Bioanalysts |
| August 2006 | >100 | 100 | >100 | 100 | Coastal Bioanalysts |
| March 2007 | >100 | 100 | >100 | 95 | Coastal Bioanalysts |
| January 2008 | >100 | 100 | >100 | 100 | Coastal Bioanalysts |
| January 2010 | >100 | 100 | >100 | 95 | Coastal Bioanalysts |
| January 2011 | >100 | 100 | >100 | 100 | Coastal Bioanalysts |
| March 2012 | >100 | 100 | >100 | 100 | Coastal Bioanalysts |

<u>Discussion</u>

Acute toxicity is not indicated.

Per Part I.B.17.c.(1) of the 2004 permit, chronic toxicity tests are only required if the discharge occurs over five consecutive days. Outfall 005 did not discharge for five consecutive days over the permit term; consequently, no chronic toxicity tests were performed.

Part I.B.17.c.(3) of the 2004 permit states that testing may be reduced to one species if the results of the data sets establish that one of the species (*C. dubia* or *P. promelas*) is less sensitive to the effluent. The tests noted above do not establish a less sensitive species for which testing could be discontinued.

Consequently, the proposed permit requires the continuation of acute and chronic WET testing with *Ceriodaphnia dubia* and *Pimephales promelas.* Because of the infrequency of the discharge (4 months of discharge between August 2008 and September 2011), the schedule will require 4 tests at least 30 days apart over the course of the permit term. This is consistent with the 2004 permitting approach. The results of those tests will be evaluated for reasonable potential at the conclusion of the permit term, or sooner if toxicity is noted, and appropriate effluent limitations established.

# Spreadsheet for determination of WET test endpoints or WET limits

| A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Excel 97** | | | **Acute Endpoint/Permit Limit** | | | **Use as $LC_{50}$ in Special Condition, as TUa on DMR** | | | | | |
| | **Revision Date: 01/10/05** | | | | | | | | | | | |
| | **File: WETLIM10.xls** | | | **ACUTE** | **100% =** | **NOAEC** | **$LC_{50}$ =** | **NA** | % Use as | **NA** | **TUa** | |
| | **(MIX.EXE required also)** | | | | | | | | | | | |
| | | | | **ACUTE WLAa** | | **0.6** | Note: Inform the permittee that if the mean of the data exceeds | | | | | |
| | | | | | | | this TUa: | 1.0 | a limit may result using WLA.EXE | | | |
| | | | | **Chronic Endpoint/Permit Limit** | | | **Use as NOEC in Special Condition, as TUc on DMR** | | | | | |
| | | | | **CHRONIC** | **6.000000147** | **$TU_c$** | **NOEC =** | **17** | % Use as | **5.88** | **$TU_c$** | |
| | | | | **BOTH*** | **6.000000147** | **$TU_c$** | **NOEC =** | **17** | % Use as | **5.88** | **$TU_c$** | |
| **Enter data in the cells with blue type:** | | | | **AML** | **6.000000147** | **$TU_c$** | **NOEC =** | **17** | % Use as | **5.88** | **$TU_c$** | |
| Entry Date: | | 08/20/12 | | **ACUTE WLAa,c** | | **6** | | Note: Inform the permittee that if the mean | | | | |
| Facility Name: | | Dominion Chesterfield Pow | | **CHRONIC WLAc** | | **50** | | of the data exceeds this TUc: | | | **2.46566808** | |
| VPDES Number: | | **VA0004146** | | * Both means acute expressed as chronic | | | | a limit may result using WLA.EXE | | | | |
| Outfall Number: | | **001** | | | | | | | | | | |
| | | | | **% Flow to be used from MIX.EXE** | | | | **Difuser /modeling study?** | | | | |
| Plant Flow: | | **212** | MGD | | | | | Enter Y/N | **Y** | | | |
| Acute 1Q10: | | **NA** | MGD | **NA** | % | | | Acute | 2 | :1 | | |
| Chronic 7Q10: | | **NA** | MGD | **NA** | % | | | Chronic | 50 | :1 | | |
| Are data available to calculate CV? (Y/N) | | | | **N** | (Minimum of 10 data points, same species, needed) | | | | | Go to Page 2 | | |
| Are data available to calculate ACR? (Y/N) | | | | **N** | (NOEC<LC50, do not use greater/less than data) | | | | | Go to Page 3 | | |
| $IWC_a$ | | 50 | % | Plant flow/plant flow + 1Q10 | | **NOTE: If the IWCa is >33%, specify the** | | | | | | |
| $IWC_c$ | | 2 | % | Plant flow/plant flow + 7Q10 | | **NOAEC = 100% test/endpoint for use** | | | | | | |
| Dilution, acute | | 2 | 100/IWCa | | | | | | | | | |
| Dilution, chronic | | 50 | 100/IWCc | | | | | | | | | |
| $WLA_a$ | | 0.6 | Instream criterion (0.3 TUa) X's Dilution, acute | | | | | | | | | |
| $WLA_c$ | | 50 | Instream criterion (1.0 TUc) X's Dilution, chronic | | | | | | | | | |
| $WLA_{a,c}$ | | 6 | ACR X's $WLA_a$ - converts acute WLA to chronic units | | | | | | | | | |
| ACR -acute/chronic ratio | | 10 | LC50/NOEC (Default is 10 - if data are available, use tables Page 3) | | | | | | | | | |
| CV-Coefficient of variatior | | 0.6 | Default of 0.6 - if data are available, use tables Page 2) | | | | | | | | | |
| Constants | eA | 0.4109447 | Default = 0.41 | | | | | | | | | |
| | eB | 0.6010373 | Default = 0.60 | | | | | | | | | |
| | eC | 2.4334175 | Default = 2.43 | | | | | | | | | |
| | eD | 2.4334175 | Default = 2.43 (1 samp) | | No. of samples | 1 | ****The Maximum Daily Limit is calculated from the lowest** | | | | | |
| | | | | | | | **LTA, X's eC. The LTAa,c and MDL using it are driven by the ACR.** | | | | | |
| $LTA_{a,c}$ | | 2.4656682 | WLAa,c X's eA | | | | | | | | | |
| $LTA_c$ | | 30.051865 | WLAc X's eB | | | | | | | Rounded NOEC's | | % |
| MDL** with $LTA_{a,c}$ | | 6.000000147 | $TU_c$ | NOEC = | 16.666666 | (Protects from acute/chronic toxicity) | | | | NOEC = | 17 | % |
| MDL** with $LTA_c$ | | 73.1287342 | $TU_c$ | NOEC = | 1.367452 | (Protects from chronic toxicity) | | | | NOEC = | 2 | % |
| AML with lowest LTA | | 6.000000147 | $TU_c$ | NOEC = | 16.666666 | Lowest LTA X's eD | | | | NOEC = | 17 | |
| IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM $TU_c$ to $TU_a$ | | | | | | | | | | | | |
| | | | | | | | | | | Rounded LC50's | | % |
| MDL with $LTA_{a,c}$ | | 0.600000015 | $TU_a$ | LC50 = | 166.666663 | % | Use NOAEC=100% | | | LC50 = | NA | % |
| MDL with $LTA_c$ | | 7.31287342 | $TU_a$ | LC50 = | 13.674515 | % | | | | LC50 = | 14 | |

## Page 2 - Follow the directions to develop a site specific CV (coefficient of variation)

| B | C | D | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|
| IF YOU HAVE AT LEAST 10 DATA POINTS THAT | | | | Vertebrate | | | Invertebrate | |
| ARE QUANTIFIABLE (NOT "<" OR ">") | | | | $IC_{25}$ Data | | | $IC_{25}$ Data | |
| FOR A SPECIES, ENTER THE DATA IN EITHER | | | | or | | | or | |
| COLUMN "G" (VERTEBRATE) OR COLUMN | | | | $LC_{50}$ Data | LN of data | | $LC_{50}$ Data | LN of data |
| "J" (INVERTEBRATE). THE 'CV' WILL BE | | | | *********** | | | *********** | |
| PICKED UP FOR THE CALCULATIONS | | | 1 | 0 | | 1 | 0 | |
| BELOW. THE DEFAULT VALUES FOR eA, | | | 2 | | | 2 | | |
| eB, AND eC WILL CHANGE IF THE 'CV' IS | | | 3 | | | 3 | | |
| ANYTHING OTHER THAN 0.6. | | | 4 | | | 4 | | |
| | | | 5 | | | 5 | | |
| | | | 6 | | | 6 | | |
| | | | 7 | | | 7 | | |
| Coefficient of Variation for effluent tests | | | 8 | | | 8 | | |
| | | | 9 | | | 9 | | |
| CV = | 0.6 | (Default 0.6) | 10 | | | 10 | | |
| | | | 11 | | | 11 | | |
| $ð^2$ = | 0.3074847 | | 12 | | | 12 | | |
| ð = | 0.554513029 | | 13 | | | 13 | | |
| | | | 14 | | | 14 | | |
| Using the log variance to develop eA | | | 15 | | | 15 | | |
| | (P. 100, step 2a of TSD) | | 16 | | | 16 | | |
| Z = 1.881 (97% probability stat from table | | | 17 | | | 17 | | |
| A = | -0.88929666 | | 18 | | | 18 | | |
| eA = | 0.410944686 | | 19 | | | 19 | | |
| | | | 20 | | | 20 | | |
| Using the log variance to develop eB | | | | | | | | |
| | (P. 100, step 2b of TSD) | | St Dev | NEED DATA | NEED DATA | St Dev | NEED DATA | NEED DATA |
| $ð_4^2$ = | 0.086177696 | | Mean | 0 | 0 | Mean | 0 | 0 |
| $ð_4$ = | 0.293560379 | | Variance | 0 | 0.000000 | Variance | 0 | 0.000000 |
| B = | -0.50909823 | | CV | 0 | | CV | 0 | |
| eB = | 0.601037335 | | | | | | | |
| | | | | | | | | |
| Using the log variance to develop eC | | | | | | | | |
| | (P. 100, step 4a of TSD) | | | | | | | |
| | | | | | | | | |
| $ð^2$ = | 0.3074847 | | | | | | | |
| ð = | 0.554513029 | | | | | | | |
| C = | 0.889296658 | | | | | | | |
| eC = | 2.433417525 | | | | | | | |
| | | | | | | | | |
| Using the log variance to develop eD | | | | | | | | |
| | (P. 100, step 4b of TSD) | | | | | | | |
| n = | 1 | This number will most likely stay as "1", for 1 sample/month. | | | | | | |
| $ð_n^2$ = | 0.3074847 | | | | | | | |
| $ð_n$ = | 0.554513029 | | | | | | | |
| D = | 0.889296658 | | | | | | | |
| eD = | 2.433417525 | | | | | | | |

## Page 3 - Follow directions to develop a site specific ACR (Acute to Chronic Ratio)

To determine Acute/Chronic Ratio (ACR), insert usable data below. Usable data is defined as valid paired test results, acute and chronic, tested at the same temperature, same species. The chronic NOEC must be less than the acute $LC_{50}$, since the ACR divides the $LC_{50}$ by the NOEC. $LC_{50}$'s >100% should not be used.

**Table 1. ACR using Vertebrate data**

| Set # | $LC_{50}$ | NOEC | Test ACR | Logarithm | Geomean | Antilog | ACR to Use |
|---|---|---|---|---|---|---|---|
| 1 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 2 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 3 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 4 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 5 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 6 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 7 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 8 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 9 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 10 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |

ACR for vertebrate data: 0

| | | |
|---|---|---|
| Table 1. Result: | Vertebrate ACR | 0 |
| Table 2. Result: | Invertebrate ACR | 0 |
| | Lowest ACR | Default to 10 |

**Table 2. ACR using Invertebrate data**

| Set # | $LC_{50}$ | NOEC | Test ACR | Logarithm | Geomean | Antilog | ACR to Use |
|---|---|---|---|---|---|---|---|
| 1 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 2 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 3 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 4 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 5 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 6 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 7 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 8 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 9 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 10 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |

ACR for vertebrate data: 0

**Convert $LC_{50}$'s and NOEC's to Chronic TU's for use in WLA.EXE**

**Table 3.** **ACR used: 10**

| | Enter $LC_{50}$ | TUc | Enter NOEC | TUc |
|---|---|---|---|---|
| 1 | >100 | #DIV/0! | 100 | 1.000000 |
| 2 | >100 | #DIV/0! | 100 | 1.000000 |
| 3 | >100 | #DIV/0! | 100 | 1.000000 |
| 4 | >100 | #DIV/0! | 100 | 1.000000 |
| 5 | >100 | #DIV/0! | 100 | 1.000000 |
| 6 | | NO DATA | | NO DATA |
| 7 | | NO DATA | | NO DATA |
| 8 | | NO DATA | | NO DATA |
| 9 | | NO DATA | | NO DATA |
| 10 | | NO DATA | | NO DATA |
| 11 | | NO DATA | | NO DATA |
| 12 | | NO DATA | | NO DATA |
| 13 | | NO DATA | | NO DATA |
| 14 | | NO DATA | | NO DATA |
| 15 | | NO DATA | | NO DATA |
| 16 | | NO DATA | | NO DATA |
| 17 | | NO DATA | | NO DATA |
| 18 | | NO DATA | | NO DATA |
| 19 | | NO DATA | | NO DATA |
| 20 | | NO DATA | | NO DATA |

If WLA.EXE determines that an acute limit is needed, you need to convert the TUc answer you get to TUa and then an LC50, enter it here:

| | | |
|---|---|---|
| enter it here: | NO DATA | $\%LC_{50}$ |
| | NO DATA | TUa |

## DILUTION SERIES TO RECOMMEND

**Table 4.**

| | Monitoring % Effluent | Monitoring TUc | Limit % Effluent | Limit TUc |
|---|---|---|---|---|
| Dilution series based on data mean | 40.6 | 2.465668 | | |
| Dilution series to use for limit | | | 17 | 5.8823529 |
| Dilution factor to recommend: | 0.6368435 | | 0.4123106 | |
| Dilution series to recommend: | 100.0 | 1.00 | 100.0 | 1.00 |
| | 63.7 | 1.57 | 41.2 | 2.43 |
| | 40.6 | 2.47 | 17.0 | 5.88 |
| | 25.8 | 3.87 | 7.0 | 14.27 |
| | 16.45 | 6.08 | 2.9 | 34.60 |
| Extra dilutions if needed | 10.48 | 9.55 | 1.2 | 83.92 |
| | 6.67 | 14.99 | 0.5 | 203.54 |

**Cell:** I9
**Comment:**
This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

**Cell:** K18
**Comment:** This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

**Cell:** J22
**Comment:** Remember to change the "N" to "Y" if you have ratios entered, otherwise, they won't be used in the calculations.

**Cell:** C40
**Comment:**
If you have entered data to calculate an ACR on page 3, and this is still defaulted to "10", make sure you have selected "Y" in cell E21

**Cell:** C41
**Comment:** If you have entered data to calculate an effluent specific CV on page 2, and this is still defaulted to "0.6", make sure you have selected "Y" in cell E20

**Cell:** L48
**Comment:**
See Row 151 for the appropriate dilution series to use for these NOEC's

**Cell:** G62
**Comment:**
Vertebrates are:
Pimephales promelas
Oncorhynchus mykiss
Cyprinodon variegatus

**Cell:** J62
**Comment:**
Invertebrates are:
Ceriodaphnia dubia
Mysidopsis bahia

**Cell:** C117
**Comment:** Vertebrates are:

Pimephales promelas
Cyprinodon variegatus

**Cell:** M119
**Comment:** The ACR has been picked up from cell C34 on Page 1. If you have paired data to calculate an ACR, enter it in the tables to the left, and make sure you have a "Y" in cell E21 on Page 1. Otherwise, the default of 10 will be used to convert your acute data.

**Cell:** M121
**Comment:** If you are only concerned with acute data, you can enter it in the NOEC column for conversion and the number calculated will be equivalent to the TUa. The calculation is the same: 100/NOEC = TUc or 100/LC50 = TUa.

**Cell:** C138
**Comment:** Invertebrates are:

Ceriodaphnia dubia
Mysidopsis bahia

# Spreadsheet for determination of WET test endpoints or WET limits

**Excel 97**
**Revision Date: 01/10/05**
**File: WETLIM10.xls**
**(MIX.EXE required also)**

**Enter data in the cells with blue type:**

| | |
|---|---|
| Entry Date: | 08/20/12 |
| Facility Name: | Dominion Chesterfield Pow |
| VPDES Number: | VA0004146 |
| Outfall Number: | 002 |

| | | |
|---|---|---|
| Plant Flow: | 89 | MGD |
| Acute 1Q10: | NA | MGD |
| Chronic 7Q10: | NA | MGD |

**Acute Endpoint/Permit Limit** — **Use as $LC_{50}$ in Special Condition, as TUa on DMR**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **ACUTE** | **100% =** | **NOAEC** | **$LC_{50}$ = NA** | % | Use as | **NA** | **TUa** |
| **ACUTE WLAa** | | **0.6** | | | | | |

Note: Inform the permittee that if the mean of the data exceeds this TUa: 1.0 a limit may result using WLA.EXE

**Chronic Endpoint/Permit Limit** — **Use as NOEC in Special Condition, as TUc on DMR**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CHRONIC** | **6.000000147** | **$TU_c$** | **NOEC =** | **17** | % Use as | **5.88** | **$TU_c$** |
| **BOTH*** | **6.000000147** | **$TU_c$** | **NOEC =** | **17** | % Use as | **5.88** | **$TU_c$** |
| **AML** | **6.000000147** | **$TU_c$** | **NOEC =** | **17** | % Use as | **5.88** | **$TU_c$** |
| **ACUTE WLAa,c** | | **6** | | | | | |
| **CHRONIC WLAc** | | **50** | | | | | |

Note: Inform the permittee that if the mean of the data exceeds this TUc: 2.46566808 a limit may result using WLA.EXE

* Both means acute expressed as chronic

**% Flow to be used from MIX.EXE**

| | |
|---|---|
| NA | % |
| NA | % |

**Difuser /modeling study?**

| | |
|---|---|
| Enter Y/N | Y |
| Acute | 2 :1 |
| Chronic | 50 :1 |

| | | | |
|---|---|---|---|
| Are data available to calculate CV? (Y/N) | N | (Minimum of 10 data points, same species, needed) | Go to Page 2 |
| Are data available to calculate ACR? (Y/N) | N | (NOEC<LC50, do not use greater/less than data) | Go to Page 3 |

| | | | |
|---|---|---|---|
| $IWC_a$ | 50 | % | Plant flow/plant flow + 1Q10 |
| $IWC_c$ | 2 | % | Plant flow/plant flow + 7Q10 |

**NOTE: If the IWCa is >33%, specify the NOAEC = 100% test/endpoint for use**

| | | |
|---|---|---|
| Dilution, acute | 2 | 100/IWCa |
| Dilution, chronic | 50 | 100/IWCc |

| | | |
|---|---|---|
| $WLA_a$ | 0.6 | Instream criterion (0.3 TUa) X's Dilution, acute |
| $WLA_c$ | 50 | Instream criterion (1.0 TUc) X's Dilution, chronic |
| $WLA_{a,c}$ | 6 | ACR X's $WLA_a$ - converts acute WLA to chronic units |

| | | | |
|---|---|---|---|
| ACR -acute/chronic ratio | | 10 | LC50/NOEC (Default is 10 - if data are available, use tables Page 3) |
| CV-Coefficient of variatior | | 0.6 | Default of 0.6 - if data are available, use tables Page 2) |
| Constants | eA | 0.4109447 | Default = 0.41 |
| | eB | 0.6010373 | Default = 0.60 |
| | eC | 2.4334175 | Default = 2.43 |
| | eD | 2.4334175 | Default = 2.43 (1 samp) No. of samples 1 |

**The Maximum Daily Limit is calculated from the lowest LTA, X's eC. The LTAa,c and MDL using it are driven by the ACR.

| | | | | | |
|---|---|---|---|---|---|
| $LTA_{a,c}$ | 2.4656682 | WLAa,c X's eA | | | |
| $LTA_c$ | 30.051865 | WLAc X's eB | | | |
| MDL** with $LTA_{a,c}$ | 6.000000147 | $TU_c$ | NOEC = | 16.666666 | (Protects from acute/chronic toxicity) |
| MDL** with $LTA_c$ | 73.1287342 | $TU_c$ | NOEC = | 1.367452 | (Protects from chronic toxicity) |
| AML with lowest LTA | 6.000000147 | $TU_c$ | NOEC = | 16.666666 | Lowest LTA X's eD |

| Rounded NOEC's | | % |
|---|---|---|
| NOEC = | 17 | % |
| NOEC = | 2 | % |
| NOEC = | 17 | |

IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM $TU_c$ to $TU_a$

| | | | | | | |
|---|---|---|---|---|---|---|
| MDL with $LTA_{a,c}$ | 0.600000015 | $TU_a$ | LC50 = | 166.666663 | % | Use NOAEC=100% |
| MDL with $LTA_c$ | 7.31287342 | $TU_a$ | LC50 = | 13.674515 | % | |

| Rounded LC50's | | % |
|---|---|---|
| LC50 = | NA | % |
| LC50 = | 14 | |

## Page 2 - Follow the directions to develop a site specific CV (coefficient of variation)

| B | C | D | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|
| IF YOU HAVE AT LEAST 10 DATA POINTS THAT | | | | Vertebrate | | | Invertebrate | |
| ARE QUANTIFIABLE (NOT "<" OR ">") | | | | $IC_{25}$ Data | | | $IC_{25}$ Data | |
| FOR A SPECIES, ENTER THE DATA IN EITHER | | | | or | | | or | |
| COLUMN "G" (VERTEBRATE) OR COLUMN | | | | $LC_{50}$ Data | LN of data | | $LC_{50}$ Data | LN of data |
| "J" (INVERTEBRATE). THE 'CV' WILL BE | | | | *********** | | | ************ | |
| PICKED UP FOR THE CALCULATIONS | | | 1 | 0 | | 1 | 0 | |
| BELOW. THE DEFAULT VALUES FOR eA, | | | 2 | | | 2 | | |
| eB, AND eC WILL CHANGE IF THE 'CV' IS | | | 3 | | | 3 | | |
| ANYTHING OTHER THAN 0.6. | | | 4 | | | 4 | | |
| | | | 5 | | | 5 | | |
| | | | 6 | | | 6 | | |
| | | | 7 | | | 7 | | |
| Coefficient of Variation for effluent tests | | | 8 | | | 8 | | |
| | | | 9 | | | 9 | | |
| CV = | 0.6 | (Default 0.6) | 10 | | | 10 | | |
| | | | 11 | | | 11 | | |
| ð$^2$ = | 0.3074847 | | 12 | | | 12 | | |
| ð = | 0.554513029 | | 13 | | | 13 | | |
| | | | 14 | | | 14 | | |
| Using the log variance to develop eA | | | 15 | | | 15 | | |
| | (P. 100, step 2a of TSD) | | 16 | | | 16 | | |
| Z = 1.881 (97% probability stat from table | | | 17 | | | 17 | | |
| A = | -0.88929666 | | 18 | | | 18 | | |
| eA = | 0.410944686 | | 19 | | | 19 | | |
| | | | 20 | | | 20 | | |
| Using the log variance to develop eB | | | | | | | | |
| | (P. 100, step 2b of TSD) | | St Dev | NEED DATA | NEED DATA | St Dev | NEED DATA | NEED DATA |
| ð$_4^2$ = | 0.086177696 | | Mean | 0 | 0 | Mean | 0 | 0 |
| ð$_4$ = | 0.293560379 | | Variance | 0 | 0.000000 | Variance | 0 | 0.000000 |
| B = | -0.50909823 | | CV | 0 | | CV | 0 | |
| eB = | 0.601037335 | | | | | | | |
| | | | | | | | | |
| Using the log variance to develop eC | | | | | | | | |
| | (P. 100, step 4a of TSD) | | | | | | | |
| | | | | | | | | |
| ð$^2$ = | 0.3074847 | | | | | | | |
| ð = | 0.554513029 | | | | | | | |
| C = | 0.889296658 | | | | | | | |
| eC = | 2.433417525 | | | | | | | |
| | | | | | | | | |
| Using the log variance to develop eD | | | | | | | | |
| | (P. 100, step 4b of TSD) | | | | | | | |
| **n =** | **1** | This number will most likely stay as "1", for 1 sample/month. | | | | | | |
| ð$_n^2$ = | 0.3074847 | | | | | | | |
| ð$_n$ = | 0.554513029 | | | | | | | |
| D = | 0.889296658 | | | | | | | |
| eD = | 2.433417525 | | | | | | | |

## Page 3 - Follow directions to develop a site specific ACR (Acute to Chronic Ratio)

To determine Acute/Chronic Ratio (ACR), insert usable data below. Usable data is defined as valid paired test results, acute and chronic, tested at the same temperature, same species. The chronic NOEC must be less than the acute $LC_{50}$, since the ACR divides the $LC_{50}$ by the NOEC. $LC_{50}$'s >100% should not be used.

**Table 1. ACR using Vertebrate data**

| Set # | $LC_{50}$ | NOEC | Test ACR | Logarithm | Geomean | Antilog | ACR to Use |
|---|---|---|---|---|---|---|---|
| 1 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 2 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 3 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 4 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 5 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 6 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 7 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 8 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 9 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 10 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| | | | | ACR for vertebrate data: | | | 0 |

| | | |
|---|---|---|
| Table 1. Result: | Vertebrate ACR | 0 |
| Table 2. Result: | Invertebrate ACR | 0 |
| | Lowest ACR | Default to 10 |

**Table 2. ACR using Invertebrate data**

| Set # | $LC_{50}$ | NOEC | Test ACR | Logarithm | Geomean | Antilog | ACR to Use |
|---|---|---|---|---|---|---|---|
| 1 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 2 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 3 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 4 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 5 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 6 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 7 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 8 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 9 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 10 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| | | | | ACR for vertebrate data: | | | 0 |

**Convert $LC_{50}$'s and NOEC's to Chronic TU's**
**for use in WLA.EXE**

**Table 3.** **ACR used: 10**

| | Enter $LC_{50}$ | TUc | Enter NOEC | TUc |
|---|---|---|---|---|
| 1 | >100 | #DIV/0! | 100 | 1.000000 |
| 2 | >100 | #DIV/0! | 100 | 1.000000 |
| 3 | >100 | #DIV/0! | 100 | 1.000000 |
| 4 | >100 | #DIV/0! | 100 | 1.000000 |
| 5 | >100 | #DIV/0! | 100 | 1.000000 |
| 6 | | NO DATA | | NO DATA |
| 7 | | NO DATA | | NO DATA |
| 8 | | NO DATA | | NO DATA |
| 9 | | NO DATA | | NO DATA |
| 10 | | NO DATA | | NO DATA |
| 11 | | NO DATA | | NO DATA |
| 12 | | NO DATA | | NO DATA |
| 13 | | NO DATA | | NO DATA |
| 14 | | NO DATA | | NO DATA |
| 15 | | NO DATA | | NO DATA |
| 16 | | NO DATA | | NO DATA |
| 17 | | NO DATA | | NO DATA |
| 18 | | NO DATA | | NO DATA |
| 19 | | NO DATA | | NO DATA |
| 20 | | NO DATA | | NO DATA |

If WLA.EXE determines that an acute limit is needed, you need to convert the TUc answer you get to TUa and then an LC50, enter it here: NO DATA $\%LC_{50}$
NO DATA TUa

**DILUTION SERIES TO RECOMMEND**

**Table 4.**

| | Monitoring % Effluent | Monitoring TUc | Limit % Effluent | Limit TUc |
|---|---|---|---|---|
| Dilution series based on data mean | 40.6 | 2.465668 | | |
| Dilution series to use for limit | | | 17 | 5.8823529 |
| Dilution factor to recommend: | 0.6368435 | | 0.4123106 | |
| Dilution series to recommend: | 100.0 | 1.00 | 100.0 | 1.00 |
| | 63.7 | 1.57 | 41.2 | 2.43 |
| | 40.6 | 2.47 | 17.0 | 5.88 |
| | 25.8 | 3.87 | 7.0 | 14.27 |
| | 16.45 | 6.08 | 2.9 | 34.60 |
| Extra dilutions if needed | 10.48 | 9.55 | 1.2 | 83.92 |
| | 6.67 | 14.99 | 0.5 | 203.54 |

**Cell:** I9
**Comment:**
This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

**Cell:** K18
**Comment:** This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

**Cell:** J22
**Comment:** Remember to change the "N" to "Y" if you have ratios entered, otherwise, they won't be used in the calculations.

**Cell:** C40
**Comment:**
If you have entered data to calculate an ACR on page 3, and this is still defaulted to "10", make sure you have selected "Y" in cell E21

**Cell:** C41
**Comment:** If you have entered data to calculate an effluent specific CV on page 2, and this is still defaulted to "0.6", make sure you have selected "Y" in cell E20

**Cell:** L48
**Comment:**
See Row 151 for the appropriate dilution series to use for these NOEC's

**Cell:** G62
**Comment:**
Vertebrates are:
Pimephales promelas
Oncorhynchus mykiss
Cyprinodon variegatus

**Cell:** J62
**Comment:**
Invertebrates are:
Ceriodaphnia dubia
Mysidopsis bahia

**Cell:** C117
**Comment:** Vertebrates are:

Pimephales promelas
Cyprinodon variegatus

**Cell:** M119
**Comment:** The ACR has been picked up from cell C34 on Page 1. If you have paired data to calculate an ACR, enter it in the tables to the left, and make sure you have a "Y" in cell E21 on Page 1. Otherwise, the default of 10 will be used to convert your acute data.

**Cell:** M121
**Comment:** If you are only concerned with acute data, you can enter it in the NOEC column for conversion and the number calculated will be equivalent to the TUa. The calculation is the same: 100/NOEC = TUc or 100/LC50 = TUa.

**Cell:** C138
**Comment:** Invertebrates are:

Ceriodaphnia dubia
Mysidopsis bahia

# Spreadsheet for determination of WET test endpoints or WET limits

| A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Excel 97** | | | **Acute Endpoint/Permit Limit** | | | **Use as $LC_{50}$ in Special Condition, as TUa on DMR** | | | | | |
| | **Revision Date: 01/10/05** | | | | | | | | | | | |
| | **File: WETLIM10.xls** | | | **ACUTE** | **100% =** | **NOAEC** | **$LC_{50}$ =** | **NA** | % Use as | **NA** | **TUa** | |
| | **(MIX.EXE required also)** | | | | | | | | | | | |
| | | | | **ACUTE WLAa** | | **0.6** | Note: Inform the permittee that if the mean of the data exceeds | | | | | |
| | | | | | | | this TUa: | **1.0** | a limit may result using WLA.EXE | | | |
| | | | | **Chronic Endpoint/Permit Limit** | | | **Use as NOEC in Special Condition, as TUc on DMR** | | | | | |
| | | | | **CHRONIC** | **6.000000147** | **$TU_c$** | **NOEC =** | **17** | % Use as | **5.88** | **$TU_c$** | |
| | | | | **BOTH*** | **6.000000147** | **$TU_c$** | **NOEC =** | **17** | % Use as | **5.88** | **$TU_c$** | |
| **Enter data in the cells with blue type:** | | | | **AML** | **6.000000147** | **$TU_c$** | **NOEC =** | **17** | % Use as | **5.88** | **$TU_c$** | |
| Entry Date: | | 08/20/12 | | **ACUTE WLAa,c** | | **6** | | Note: Inform the permittee that if the mean | | | | |
| Facility Name: | | Dominion Chesterfield Pow | | **CHRONIC WLAc** | | **50** | | of the data exceeds this TUc: | | | **2.46566808** | |
| VPDES Number: | | **VA0004146** | | * Both means acute expressed as chronic | | | | a limit may result using WLA.EXE | | | | |
| Outfall Number: | | **003** | | | | | | | | | | |
| | | | | **% Flow to be used from MIX.EXE** | | | | **Difuser /modeling study?** | | | | |
| Plant Flow: | | **757** | MGD | | | | | Enter Y/N | **Y** | | | |
| Acute 1Q10: | | **NA** | MGD | **NA** | % | | | Acute | 2 | :1 | | |
| Chronic 7Q10: | | **NA** | MGD | **NA** | % | | | Chronic | 50 | :1 | | |
| Are data available to calculate CV? (Y/N) | | | | **N** | (Minimum of 10 data points, same species, needed) | | | | | Go to Page 2 | | |
| Are data available to calculate ACR? (Y/N) | | | | **N** | (NOEC<LC50, do not use greater/less than data) | | | | | Go to Page 3 | | |
| $IWC_a$ | | 50 | % Plant flow/plant flow + 1Q10 | | | **NOTE: If the IWCa is >33%, specify the** | | | | | | |
| $IWC_c$ | | 2 | % Plant flow/plant flow + 7Q10 | | | **NOAEC = 100% test/endpoint for use** | | | | | | |
| Dilution, acute | | 2 | 100/IWCa | | | | | | | | | |
| Dilution, chronic | | 50 | 100/IWCc | | | | | | | | | |
| $WLA_a$ | | 0.6 | Instream criterion (0.3 TUa) X's Dilution, acute | | | | | | | | | |
| $WLA_c$ | | 50 | Instream criterion (1.0 TUc) X's Dilution, chronic | | | | | | | | | |
| $WLA_{a,c}$ | | 6 | ACR X's $WLA_a$ - converts acute WLA to chronic units | | | | | | | | | |
| ACR -acute/chronic ratio | | 10 | LC50/NOEC (Default is 10 - if data are available, use tables Page 3) | | | | | | | | | |
| CV-Coefficient of variatior | | 0.6 | Default of 0.6 - if data are available, use tables Page 2) | | | | | | | | | |
| Constants | eA | 0.4109447 | Default = 0.41 | | | | | | | | | |
| | eB | 0.6010373 | Default = 0.60 | | | | | | | | | |
| | eC | 2.4334175 | Default = 2.43 | | | | | | | | | |
| | eD | 2.4334175 | Default = 2.43 (1 samp) | | No. of samples | 1 | ****The Maximum Daily Limit is calculated from the lowest** | | | | | |
| | | | | | | | **LTA, X's eC. The LTAa,c and MDL using it are driven by the ACR.** | | | | | |
| $LTA_{a,c}$ | | 2.4656682 | WLAa,c X's eA | | | | | | | | | |
| $LTA_c$ | | 30.051865 | WLAc X's eB | | | | | | | Rounded NOEC's | | % |
| MDL** with $LTA_{a,c}$ | | 6.000000147 | $TU_c$ | NOEC = | 16.666666 | (Protects from acute/chronic toxicity) | | | | NOEC = | 17 | % |
| MDL** with $LTA_c$ | | 73.1287342 | $TU_c$ | NOEC = | 1.367452 | (Protects from chronic toxicity) | | | | NOEC = | 2 | % |
| AML with lowest LTA | | 6.000000147 | $TU_c$ | NOEC = | 16.666666 | Lowest LTA X's eD | | | | NOEC = | 17 | |
| IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM $TU_c$ to $TU_a$ | | | | | | | | | | | | |
| | | | | | | | | | | Rounded LC50's | | % |
| MDL with $LTA_{a,c}$ | | 0.600000015 | $TU_a$ | LC50 = | 166.666663 | % | Use NOAEC=100% | | | LC50 = | NA | % |
| MDL with $LTA_c$ | | 7.31287342 | $TU_a$ | LC50 = | 13.674515 | % | | | | LC50 = | 14 | |

## Page 2 - Follow the directions to develop a site specific CV (coefficient of variation)

| | B | C | D | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|
| 59 | | | | | | | | | |
| 60 | Page 2 - Follow the directions to develop a site specific CV (coefficient of variation) | | | | | | | | |
| 61 | | | | | | | | | |
| 62 | IF YOU HAVE AT LEAST 10 DATA POINTS THAT | | | | Vertebrate | | | Invertebrate | |
| 63 | ARE QUANTIFIABLE (NOT "<" OR ">") | | | | $IC_{25}$ Data | | | $IC_{25}$ Data | |
| 64 | FOR A SPECIES, ENTER THE DATA IN EITHER | | | | or | | | or | |
| 65 | COLUMN "G" (VERTEBRATE) OR COLUMN | | | | $LC_{50}$ Data | LN of data | | $LC_{50}$ Data | LN of data |
| 66 | "J" (INVERTEBRATE). THE 'CV' WILL BE | | | | *********** | | | ************ | |
| 67 | PICKED UP FOR THE CALCULATIONS | | | 1 | 0 | | 1 | 0 | |
| 68 | BELOW. THE DEFAULT VALUES FOR eA, | | | 2 | | | 2 | | |
| 69 | eB, AND eC WILL CHANGE IF THE 'CV' IS | | | 3 | | | 3 | | |
| 70 | ANYTHING OTHER THAN 0.6. | | | 4 | | | 4 | | |
| 71 | | | | 5 | | | 5 | | |
| 72 | | | | 6 | | | 6 | | |
| 73 | | | | 7 | | | 7 | | |
| 74 | Coefficient of Variation for effluent tests | | | 8 | | | 8 | | |
| 75 | | | | 9 | | | 9 | | |
| 76 | CV = | 0.6 | (Default 0.6) | 10 | | | 10 | | |
| 77 | | | | 11 | | | 11 | | |
| 78 | ð$^2$ = | 0.3074847 | | 12 | | | 12 | | |
| 79 | ð = | 0.554513029 | | 13 | | | 13 | | |
| 80 | | | | 14 | | | 14 | | |
| 81 | Using the log variance to develop eA | | | 15 | | | 15 | | |
| 82 | | (P. 100, step 2a of TSD) | | 16 | | | 16 | | |
| 83 | Z = 1.881 (97% probability stat from table | | | 17 | | | 17 | | |
| 84 | A = | -0.88929666 | | 18 | | | 18 | | |
| 85 | eA = | 0.410944686 | | 19 | | | 19 | | |
| 86 | | | | 20 | | | 20 | | |
| 87 | Using the log variance to develop eB | | | | | | | | |
| 88 | | (P. 100, step 2b of TSD) | | St Dev | NEED DATA | NEED DATA | St Dev | NEED DAT/ | NEED DATA |
| 89 | ð$_4^2$ = | 0.086177696 | | Mean | 0 | 0 | Mean | 0 | 0 |
| 90 | ð$_4$ = | 0.293560379 | | Variance | 0 | 0.000000 | Variance | 0 | 0.000000 |
| 91 | B = | -0.50909823 | | CV | 0 | | CV | 0 | |
| 92 | eB = | 0.601037335 | | | | | | | |
| 93 | | | | | | | | | |
| 94 | Using the log variance to develop eC | | | | | | | | |
| 95 | | (P. 100, step 4a of TSD) | | | | | | | |
| 96 | | | | | | | | | |
| 97 | ð$^2$ = | 0.3074847 | | | | | | | |
| 98 | ð = | 0.554513029 | | | | | | | |
| 99 | C = | 0.889296658 | | | | | | | |
| 100 | eC = | 2.433417525 | | | | | | | |
| 101 | | | | | | | | | |
| 102 | Using the log variance to develop eD | | | | | | | | |
| 103 | | (P. 100, step 4b of TSD) | | | | | | | |
| 104 | n = | 1 | This number will most likely stay as "1", for 1 sample/month. | | | | | | |
| 105 | ð$_n^2$ = | 0.3074847 | | | | | | | |
| 106 | ð$_n$ = | 0.554513029 | | | | | | | |
| 107 | D = | 0.889296658 | | | | | | | |
| 108 | eD = | 2.433417525 | | | | | | | |
| 109 | | | | | | | | | |

## Page 3 - Follow directions to develop a site specific ACR (Acute to Chronic Ratio)

To determine Acute/Chronic Ratio (ACR), insert usable data below. Usable data is defined as valid paired test results, acute and chronic, tested at the same temperature, same species. The chronic NOEC must be less than the acute $LC_{50}$, since the ACR divides the $LC_{50}$ by the NOEC. $LC_{50}$'s >100% should not be used.

**Table 1. ACR using Vertebrate data**

| Set # | $LC_{50}$ | NOEC | Test ACR | Logarithm | Geomean | Antilog | ACR to Use |
|---|---|---|---|---|---|---|---|
| 1 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 2 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 3 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 4 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 5 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 6 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 7 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 8 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 9 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 10 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| | | | | ACR for vertebrate data: | | | 0 |

| | | | |
|---|---|---|---|
| Table 1. Result: | Vertebrate ACR | | 0 |
| Table 2. Result: | Invertebrate ACR | | 0 |
| | Lowest ACR | | Default to 10 |

**Table 2. ACR using Invertebrate data**

| Set # | $LC_{50}$ | NOEC | Test ACR | Logarithm | Geomean | Antilog | ACR to Use |
|---|---|---|---|---|---|---|---|
| 1 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 2 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 3 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 4 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 5 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 6 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 7 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 8 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 9 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 10 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| | | | | ACR for vertebrate data: | | | 0 |

**Convert $LC_{50}$'s and NOEC's to Chronic TU's**
**for use in WLA.EXE**

**Table 3.** **ACR used: 10**

| | Enter $LC_{50}$ | TUc | Enter NOEC | TUc |
|---|---|---|---|---|
| 1 | >100 | #DIV/0! | 100 | 1.000000 |
| 2 | >100 | #DIV/0! | 100 | 1.000000 |
| 3 | >100 | #DIV/0! | 100 | 1.000000 |
| 4 | >100 | #DIV/0! | 100 | 1.000000 |
| 5 | >100 | #DIV/0! | 100 | 1.000000 |
| 6 | | NO DATA | | NO DATA |
| 7 | | NO DATA | | NO DATA |
| 8 | | NO DATA | | NO DATA |
| 9 | | NO DATA | | NO DATA |
| 10 | | NO DATA | | NO DATA |
| 11 | | NO DATA | | NO DATA |
| 12 | | NO DATA | | NO DATA |
| 13 | | NO DATA | | NO DATA |
| 14 | | NO DATA | | NO DATA |
| 15 | | NO DATA | | NO DATA |
| 16 | | NO DATA | | NO DATA |
| 17 | | NO DATA | | NO DATA |
| 18 | | NO DATA | | NO DATA |
| 19 | | NO DATA | | NO DATA |
| 20 | | NO DATA | | NO DATA |

If WLA.EXE determines that an acute limit is needed, you need to convert the TUc answer you get to TUa and then an LC50, enter it here:

| | | |
|---|---|---|
| enter it here: | NO DATA | $\%LC_{50}$ |
| | NO DATA | TUa |

### DILUTION SERIES TO RECOMMEND

**Table 4.**

| | Monitoring % Effluent | Monitoring TUc | Limit % Effluent | Limit TUc |
|---|---|---|---|---|
| Dilution series based on data mean | 40.6 | 2.465668 | | |
| Dilution series to use for limit | | | 17 | 5.8823529 |
| Dilution factor to recommend: | 0.6368435 | | 0.4123106 | |
| Dilution series to recommend: | 100.0 | 1.00 | 100.0 | 1.00 |
| | 63.7 | 1.57 | 41.2 | 2.43 |
| | 40.6 | 2.47 | 17.0 | 5.88 |
| | 25.8 | 3.87 | 7.0 | 14.27 |
| | 16.45 | 6.08 | 2.9 | 34.60 |
| Extra dilutions if needed | 10.48 | 9.55 | 1.2 | 83.92 |
| | 6.67 | 14.99 | 0.5 | 203.54 |

**Cell:** I9
**Comment:**
This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

**Cell:** K18
**Comment:** This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

**Cell:** J22
**Comment:** Remember to change the "N" to "Y" if you have ratios entered, otherwise, they won't be used in the calculations.

**Cell:** C40
**Comment:**
If you have entered data to calculate an ACR on page 3, and this is still defaulted to "10", make sure you have selected "Y" in cell E21

**Cell:** C41
**Comment:** If you have entered data to calculate an effluent specific CV on page 2, and this is still defaulted to "0.6", make sure you have selected "Y" in cell E20

**Cell:** L48
**Comment:**
See Row 151 for the appropriate dilution series to use for these NOEC's

**Cell:** G62
**Comment:**
Vertebrates are:
Pimephales promelas
Oncorhynchus mykiss
Cyprinodon variegatus

**Cell:** J62
**Comment:**
Invertebrates are:
Ceriodaphnia dubia
Mysidopsis bahia

**Cell:** C117
**Comment:** Vertebrates are:

Pimephales promelas
Cyprinodon variegatus

**Cell:** M119
**Comment:** The ACR has been picked up from cell C34 on Page 1. If you have paired data to calculate an ACR, enter it in the tables to the left, and make sure you have a "Y" in cell E21 on Page 1. Otherwise, the default of 10 will be used to convert your acute data.

**Cell:** M121
**Comment:** If you are only concerned with acute data, you can enter it in the NOEC column for conversion and the number calculated will be equivalent to the TUa. The calculation is the same: 100/NOEC = TUc or 100/LC50 = TUa.

**Cell:** C138
**Comment:** Invertebrates are:

Ceriodaphnia dubia
Mysidopsis bahia

# Spreadsheet for determination of WET test endpoints or WET limits

**Excel 97**
**Revision Date: 01/10/05**
**File: WETLIM10.xls**
**(MIX.EXE required also)**

| Acute Endpoint/Permit Limit | | | Use as $LC_{50}$ in Special Condition, as TUa on DMR | | | | |
|---|---|---|---|---|---|---|---|
| ACUTE | 5.031065727 | TUa | $LC_{50}$ = | 20 | % Use as | 5.00 | TUa |
| ACUTE WLAa | | 10.3196078 | Note: Inform the permittee that if the mean of the data exceeds | | | | |
| | | | this TUa: | 1.41359551 | a limit may result using WLA.EXE | | |

| Chronic Endpoint/Permit Limit | | | Use as NOEC in Special Condition, as TUc on DMR | | | | |
|---|---|---|---|---|---|---|---|
| CHRONIC | 50.31065727 | $TU_c$ | NOEC = | 2 | % Use as | 50.00 | $TU_c$ |
| BOTH* | 103.196081 | $TU_c$ | NOEC = | 1 | % Use as | 100.00 | $TU_c$ |
| AML | 50.31065727 | $TU_c$ | NOEC = | 2 | % Use as | 50.00 | $TU_c$ |
| ACUTE WLAa,c | | 103.196078 | Note: Inform the permittee that if the mean | | | | |
| CHRONIC WLAc | | 34.3986928 | of the data exceeds this TUc: | | | | 20.6748965 |
| * Both means acute expressed as chronic | | | a limit may result using WLA.EXE | | | | |

**Enter data in the cells with blue type:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Entry Date: | 08/16/12 | | | | | | |
| Facility Name: | Dominion Chesterfield Pow | | | | | | |
| VPDES Number: | VA0004146 | | | | | | |
| Outfall Number: | 004 | | **% Flow to be used from MIX.EXE** | | **Difuser /modeling study?** | | |
| Plant Flow: | 15.3 | MGD | | | Enter Y/N | N | |
| Acute 1Q10: | 511 | MGD | 100 | % | Acute | 1 | :1 |
| Chronic 7Q10: | 511 | MGD | 100 | % | Chronic | 49 | :1 |

| | | | |
|---|---|---|---|
| Are data available to calculate CV? (Y/N) | N | (Minimum of 10 data points, same species, needed) | Go to Page 2 |
| Are data available to calculate ACR? (Y/N) | N | (NOEC<LC50, do not use greater/less than data) | Go to Page 3 |

| | | | |
|---|---|---|---|
| $IWC_a$ | 2.907087213 | % | Plant flow/plant flow + 1Q10 |
| $IWC_c$ | 2.907087213 | % | Plant flow/plant flow + 7Q10 |

**NOTE: If the IWCa is >33%, specify the NOAEC = 100% test/endpoint for use**

| | | |
|---|---|---|
| Dilution, acute | 34.39869281 | 100/IWCa |
| Dilution, chronic | 34.39869281 | 100/IWCc |
| $WLA_a$ | 10.31960784 | Instream criterion (0.3 TUa) X's Dilution, acute |
| $WLA_c$ | 34.39869281 | Instream criterion (1.0 TUc) X's Dilution, chronic |
| $WLA_{a,c}$ | 103.1960784 | ACR X's $WLA_a$ - converts acute WLA to chronic units |
| ACR -acute/chronic ratio | 10 | LC50/NOEC (Default is 10 - if data are available, use tables Page 3) |
| CV-Coefficient of variatior | 0.6 | Default of 0.6 - if data are available, use tables Page 2) |
| Constants eA | 0.4109447 | Default = 0.41 |
| eB | 0.6010373 | Default = 0.60 |
| eC | 2.4334175 | Default = 2.43 |
| eD | 2.4334175 | Default = 2.43 (1 samp) No. of samples 1 |

**The Maximum Daily Limit is calculated from the lowest LTA, X's eC. The LTAa,c and MDL using it are driven by the ACR.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $LTA_{a,c}$ | 42.40788149 | WLAa,c X's eA | | | | | | |
| $LTA_c$ | 20.67489745 | WLAc X's eB | | | | Rounded NOEC's | | % |
| MDL** with $LTA_{a,c}$ | 103.196081 | $TU_c$ | NOEC = | 0.969029 | (Protects from acute/chronic toxicity) | NOEC = | 1 | % |
| MDL** with $LTA_c$ | 50.31065727 | $TU_c$ | NOEC = | 1.987650 | (Protects from chronic toxicity) | NOEC = | 2 | % |
| AML with lowest LTA | 50.31065727 | $TU_c$ | NOEC = | 1.987650 | Lowest LTA X's eD | NOEC = | 2 | |

IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM $TU_c$ to $TU_a$

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Rounded LC50's | | % |
| MDL with $LTA_{a,c}$ | 10.3196081 | $TU_a$ | LC50 = | 9.690290 | % | LC50 = | 10 | % |
| MDL with $LTA_c$ | 5.031065727 | $TU_a$ | LC50 = | 19.876504 | % | LC50 = | 20 | |

## Page 2 - Follow the directions to develop a site specific CV (coefficient of variation)

| B | C | D | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|
| IF YOU HAVE AT LEAST 10 DATA POINTS THAT | | | | Vertebrate | | | Invertebrate | |
| ARE QUANTIFIABLE (NOT "<" OR ">") | | | | $IC_{25}$ Data | | | $IC_{25}$ Data | |
| FOR A SPECIES, ENTER THE DATA IN EITHER | | | | or | | | or | |
| COLUMN "G" (VERTEBRATE) OR COLUMN | | | | $LC_{50}$ Data | LN of data | | $LC_{50}$ Data | LN of data |
| "J" (INVERTEBRATE). THE 'CV' WILL BE | | | | *********** | | | ************ | |
| PICKED UP FOR THE CALCULATIONS | | | 1 | 0 | | 1 | 0 | |
| BELOW. THE DEFAULT VALUES FOR eA, | | | 2 | | | 2 | | |
| eB, AND eC WILL CHANGE IF THE 'CV' IS | | | 3 | | | 3 | | |
| ANYTHING OTHER THAN 0.6. | | | 4 | | | 4 | | |
| | | | 5 | | | 5 | | |
| | | | 6 | | | 6 | | |
| | | | 7 | | | 7 | | |
| Coefficient of Variation for effluent tests | | | 8 | | | 8 | | |
| | | | 9 | | | 9 | | |
| CV = | 0.6 | (Default 0.6) | 10 | | | 10 | | |
| | | | 11 | | | 11 | | |
| ð$^2$ = | 0.3074847 | | 12 | | | 12 | | |
| ð = | 0.554513029 | | 13 | | | 13 | | |
| | | | 14 | | | 14 | | |
| Using the log variance to develop eA | | | 15 | | | 15 | | |
| | (P. 100, step 2a of TSD) | | 16 | | | 16 | | |
| Z = 1.881 (97% probability stat from table | | | 17 | | | 17 | | |
| A = | -0.88929666 | | 18 | | | 18 | | |
| eA = | 0.410944686 | | 19 | | | 19 | | |
| | | | 20 | | | 20 | | |
| Using the log variance to develop eB | | | | | | | | |
| | (P. 100, step 2b of TSD) | | St Dev | NEED DATA | NEED DATA | St Dev | NEED DATA | NEED DATA |
| ð$_4^2$ = | 0.086177696 | | Mean | 0 | 0 | Mean | 0 | 0 |
| ð$_4$ = | 0.293560379 | | Variance | 0 | 0.000000 | Variance | 0 | 0.000000 |
| B = | -0.50909823 | | CV | 0 | | CV | 0 | |
| eB = | 0.601037335 | | | | | | | |
| | | | | | | | | |
| Using the log variance to develop eC | | | | | | | | |
| | (P. 100, step 4a of TSD) | | | | | | | |
| | | | | | | | | |
| ð$^2$ = | 0.3074847 | | | | | | | |
| ð = | 0.554513029 | | | | | | | |
| C = | 0.889296658 | | | | | | | |
| eC = | 2.433417525 | | | | | | | |
| | | | | | | | | |
| Using the log variance to develop eD | | | | | | | | |
| | (P. 100, step 4b of TSD) | | | | | | | |
| **n =** | **1** | This number will most likely stay as "1", for 1 sample/month. | | | | | | |
| ð$_n^2$ = | 0.3074847 | | | | | | | |
| ð$_n$ = | 0.554513029 | | | | | | | |
| D = | 0.889296658 | | | | | | | |
| eD = | 2.433417525 | | | | | | | |

## Page 3 - Follow directions to develop a site specific ACR (Acute to Chronic Ratio)

To determine Acute/Chronic Ratio (ACR), insert usable data below. Usable data is defined as valid paired test results, acute and chronic, tested at the same temperature, same species. The chronic NOEC must be less than the acute $LC_{50}$, since the ACR divides the $LC_{50}$ by the NOEC. $LC_{50}$'s >100% should not be used.

**Table 1. ACR using Vertebrate data**

| Set # | $LC_{50}$ | NOEC | Test ACR | Logarithm | Geomean | Antilog | ACR to Use |
|---|---|---|---|---|---|---|---|
| 1 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 2 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 3 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 4 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 5 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 6 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 7 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 8 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 9 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 10 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| | | | | ACR for vertebrate data: | | | 0 |

| | | | |
|---|---|---|---|
| Table 1. Result: | Vertebrate ACR | | 0 |
| Table 2. Result: | Invertebrate ACR | | 0 |
| | Lowest ACR | | Default to 10 |

**Table 2. ACR using Invertebrate data**

| Set # | $LC_{50}$ | NOEC | Test ACR | Logarithm | Geomean | Antilog | ACR to Use |
|---|---|---|---|---|---|---|---|
| 1 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 2 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 3 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 4 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 5 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 6 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 7 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 8 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 9 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| 10 | | | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0 |
| | | | | ACR for vertebrate data: | | | 0 |

**Convert $LC_{50}$'s and NOEC's to Chronic TU's**
**for use in WLA.EXE**

**Table 3.** **ACR used: 10**

| | Enter $LC_{50}$ | TUc | Enter NOEC | TUc |
|---|---|---|---|---|
| 1 | >37 | #DIV/0! | 4 | 25.000000 |
| 2 | >37 | #DIV/0! | 32 | 3.125000 |
| 3 | >100 | #DIV/0! | 100 | 1.000000 |
| 4 | >100 | #DIV/0! | 32 | 3.125000 |
| 5 | >100 | #DIV/0! | 100 | 1.000000 |
| 6 | >100 | #DIV/0! | 32 | 3.125000 |
| 7 | >100 | #DIV/0! | 32 | 3.125000 |
| 8 | | NO DATA | | NO DATA |
| 9 | | NO DATA | | NO DATA |
| 10 | | NO DATA | | NO DATA |
| 11 | | NO DATA | | NO DATA |
| 12 | | NO DATA | | NO DATA |
| 13 | | NO DATA | | NO DATA |
| 14 | | NO DATA | | NO DATA |
| 15 | | NO DATA | | NO DATA |
| 16 | | NO DATA | | NO DATA |
| 17 | | NO DATA | | NO DATA |
| 18 | | NO DATA | | NO DATA |
| 19 | | NO DATA | | NO DATA |
| 20 | | NO DATA | | NO DATA |

If WLA.EXE determines that an acute limit is needed, you need to convert the TUc answer you get to TUa and then an LC50, enter it here:

| | | |
|---|---|---|
| enter it here: | NO DATA | %$LC_{50}$ |
| | NO DATA | TUa |

**DILUTION SERIES TO RECOMMEND**

**Table 4.**

| | Monitoring % Effluent | Monitoring TUc | Limit % Effluent | Limit TUc |
|---|---|---|---|---|
| Dilution series based on data mean | 4.8 | 20.6749 | | |
| Dilution series to use for limit | | | 2 | 50 |
| Dilution factor to recommend: | 0.2199269 | | 0.1414214 | |
| Dilution series to recommend: | 100.0 | 1.00 | 100.0 | 1.00 |
| | 22.0 | 4.55 | 14.1 | 7.07 |
| | 4.8 | 20.67 | 2.0 | 50.00 |
| | 1.1 | 94.01 | 0.3 | 353.55 |
| | 0.23 | 427.45 | 0.0 | 2500.00 |
| Extra dilutions if needed | 0.05 | 1943.61 | 0.0 | 17677.67 |
| | 0.01 | 8837.51 | 0.0 | 125000.00 |

**Cell:** I9
**Comment:**
This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

**Cell:** K18
**Comment:** This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

**Cell:** J22
**Comment:** Remember to change the "N" to "Y" if you have ratios entered, otherwise, they won't be used in the calculations.

**Cell:** C40
**Comment:**
If you have entered data to calculate an ACR on page 3, and this is still defaulted to "10", make sure you have selected "Y" in cell E21

**Cell:** C41
**Comment:** If you have entered data to calculate an effluent specific CV on page 2, and this is still defaulted to "0.6", make sure you have selected "Y" in cell E20

**Cell:** L48
**Comment:**
See Row 151 for the appropriate dilution series to use for these NOEC's

**Cell:** G62
**Comment:**
Vertebrates are:
Pimephales promelas
Oncorhynchus mykiss
Cyprinodon variegatus

**Cell:** J62
**Comment:**
Invertebrates are:
Ceriodaphnia dubia
Mysidopsis bahia

**Cell:** C117
**Comment:** Vertebrates are:

Pimephales promelas
Cyprinodon variegatus

**Cell:** M119
**Comment:** The ACR has been picked up from cell C34 on Page 1. If you have paired data to calculate an ACR, enter it in the tables to the left, and make sure you have a "Y" in cell E21 on Page 1. Otherwise, the default of 10 will be used to convert your acute data.

**Cell:** M121
**Comment:** If you are only concerned with acute data, you can enter it in the NOEC column for conversion and the number calculated will be equivalent to the TUa. The calculation is the same: 100/NOEC = TUc or 100/LC50 = TUa.

**Cell:** C138
**Comment:** Invertebrates are:

Ceriodaphnia dubia
Mysidopsis bahia

```
Facility  = Dominion Chesterfield Power Station (Outfall 004)
Chemical  = Chronic WET
Chronic averaging period =  4
WLAa    =  103.1961 TUc
WLAc    =  34.39869 TUc
Q.L.      = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 8
Expected Value =  5.33125
Variance       =  10.2320
C.V.           = 0.6
97th percentile daily values  =  12.9731
97th percentile 4 day average =  8.87008
97th percentile 30 day average=  6.42977
# < Q.L.       =  0
Model used     = BPJ Assumptions, type 2 data


No Limit is required for this material


The data are (TUc):


25
3.13
3.13
1
3.13
1
3.13
3.13
```

The chronic toxicity data for reproduction are entered above in chronic toxicity units (TUc), which are calculated by dividing 100 by the NOEC. Example: For a NOEC of 100%, TUc equals 100 /100% = 1.

Based on the last 5 years of testing, no limit is required. However, there is a chronic toxicity limitation in the current permit (Max TUc = 50) that will be carried forward in this reissuance.

# 2004 Evaluation and Limitation Development

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | |
| 2 | | **Spreadsheet for determination of WET test endpoints or WET limits** | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | |
| 4 | | **Excel 97** | | | **Acute Endpoint/Permit Limit** | | | **Use as $LC_{50}$ in Special Condition, as TUa on DMR** | | | | | | | |
| 5 | | **Revision Date: 06/07/04** | | | | | | | | | | | | | |
| 6 | | **File: WETLIM10.xls** | | | ACUTE | 7.94123884 | TUa | $LC_{50}$ = | 13 | % Use as | 7.69 | TUa | | | |
| 7 | | **(MIX.EXE required also)** | | | | | | | | | | | | | |
| 8 | | | | | ACUTE WLAa | | 16.2888889 | Note: Inform the permittee that if the mean of the data exceeds | | | | | | | |
| 9 | | | | | | | | this TUa: | 2.23127867 | a limit may result using WLA.EXE | | | | | |
| 10 | | | | | | | | | | | | | | | |
| 11 | | | | | Chronic Endpoint/Permit Limit | | | Use as NOEC in Special Condition, as TUc on DMR | | | | | | | |
| 12 | | | | | | | | | | | | | | | |
| 13 | | | | | CHRONIC | 79.4123884 | $TU_c$ | NOEC = | 2 | % Use as | 50.00 | $TU_c$ | | | |
| 14 | | | | | BOTH* | 162.8888929 | $TU_c$ | NOEC = | 1 | % Use as | 100.00 | $TU_c$ | | | |
| 15 | **Enter data in the cells with blue type:** | | | | AML | 79.4123884 | $TU_c$ | NOEC = | 2 | % Use as | 50.00 | $TU_c$ | | | |
| 16 | | | | | | | | | | | | | | | |
| 17 | Entry Date: | | 06/15/04 | | ACUTE WLAa,c | | 162.888889 | | Note: Inform the permittee that if the mean | | | | | | |
| 18 | Facility Name: | | VaP-Chesterfield | | CHRONIC WLAc | | 54.2962963 | | of the data exceeds this TUc: | | | 32.6340978 | | | |
| 19 | VPDES Number: | | VA0004146 | | * Both means acute expressed as chronic | | | | a limit may result using WLA.EXE | | | | | | |
| 20 | Outfall Number: | | 4 | | | | | | | | | | | | |
| 21 | | | | | % Flow to be used from MIX.EXE | | | | Diffuser /modeling study? | | | | | | |
| 22 | Plant Flow: | | 13.5 | MGD | | | | | Enter Y/N | N | | | | | |
| 23 | Acute 1Q10: | | 719.5 | MGD | 100 | % | | | Acute | 1 | :1 | | | | |
| 24 | Chronic 7Q10: | | 719.5 | MGD | 100 | % | | | Chronic | 1 | :1 | | | | |
| 25 | | | | | | | | | | | | | | | |
| 26 | Are data available to calculate CV? (Y/N) | | | | N | (Minimum of 10 data points, same species, needed) | | | | | Go to Page 2 | | | | |
| 27 | Are data available to calculate ACR? (Y/N) | | | | N | (NOEC<LC50, do not use greater/less than data) | | | | | Go to Page 3 | | | | |
| 28 | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | |
| 30 | $IWC_a$ | | 1.84174625 | % Plant flow/plant flow + 1Q10 | | | NOTE: If the IWCa is >33%, specify the | | | | | | | | |
| 31 | $IWC_c$ | | 1.84174625 | % Plant flow/plant flow + 7Q10 | | | NOAEC = 100% test/endpoint for use | | | | | | | | |
| 32 | | | | | | | | | | | | | | | |
| 33 | Dilution, acute | | 54.2962963 | 100/IWCa | | | | | | | | | | | |
| 34 | Dilution, chronic | | 54.2962963 | 100/IWCc | | | | | | | | | | | |
| 35 | | | | | | | | | | | | | | | |
| 36 | $WLA_a$ | | 16.2888889 | Instream criterion (0.3 TUa) X's Dilution, acute | | | | | | | | | | | |
| 37 | $WLA_c$ | | 54.2962963 | Instream criterion (1.0 TUc) X's Dilution, chronic | | | | | | | | | | | |
| 38 | $WLA_{a,c}$ | | 162.888889 | ACR X's $WLA_a$ - converts acute WLA to chronic units | | | | | | | | | | | |
| 39 | | | | | | | | | | | | | | | |
| 40 | ACR -acute/chronic ratio | | 10 | LC50/NOEC (Default is 10 - if data are available, use tables Page 3) | | | | | | | | | | | |
| 41 | CV-Coefficient of variatior | | 0.6 | Default of 0.6 - if data are available, use tables Page 2) | | | | | | | | | | | |
| 42 | Constants | eA | 0.4109447 | Default = 0.41 | | | | | | | | | | | |
| 43 | | eB | 0.6010373 | Default = 0.60 | | | | | | | | | | | |
| 44 | | eC | 2.4334175 | Default = 2.43 | | | | | | | | | | | |
| 45 | | eD | 2.4334175 | Default = 2.43 (1 samp) | | | **The Maximum Daily Limit is calculated from the lowest | | | | | | | | |
| 46 | | | | | | | LTA, X's eC. The LTAa,c and MDL using it are driven by the ACR. | | | | | | | | |
| 47 | $LTA_{a,c}$ | | 66.9383256 | WLAa,c X's eA | | | | | | | | | | | |
| 48 | $LTA_c$ | | 32.6340993 | WLAc X's eB | | | | | | | Rounded NOEC's | | % | | |
| 49 | MDL** with $LTA_{a,c}$ | | 162.888893 | $TU_c$ | NOEC = | 0.613915 | (Protects from acute/chronic toxicity) | | | | NOEC = | 1 | % | | |
| 50 | MDL** with $LTA_c$ | | 79.4123884 | $TU_c$ | NOEC = | 1.259249 | (Protects from chronic toxicity) | | | | NOEC = | 2 | % | | |
| 51 | AML with lowest LTA | | 79.4123884 | $TU_c$ | NOEC = | 1.259249 | Lowest LTA X's eD | | | | NOEC = | 2 | | | |
| 52 | | | | | | | | | | | | | | | |
| 53 | IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM $TU_c$ to $TU_a$ | | | | | | | | | | | | | | |
| 54 | | | | | | | | | | | Rounded LC50's | | % | | |
| 55 | MDL with $LTA_{a,c}$ | | 16.2888893 | $TU_a$ | LC50 = | 6.139154 | % | | | | LC50 = | 7 | % | | |
| 56 | MDL with $LTA_c$ | | 7.94123884 | $TU_a$ | LC50 = | 12.592494 | % | | | | LC50 = | 13 | | | |
| 57 | | | | | | | | | | | | | | | |
| 58 | | | | | | | | | | | | | | | |

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | | | | | | | | | | | | | | | |
| 60 | | **Page 2 - Follow the directions to develop a site specific CV (coefficient of variation)** | | | | | | | | | | | | | |
| 61 | | | | | | | | | | | | | | | |
| 62 | | IF YOU HAVE AT LEAST 10 DATA POINTS THAT | | | | | Vertebrate | | | Invertebrate | | | | | |
| 63 | | ARE QUANTIFIABLE (NOT "<" OR ">") | | | | | $IC_{25}$ Data | | | $IC_{25}$ Data | | | | | |
| 64 | | FOR A SPECIES, ENTER THE DATA IN EITHER | | | | | or | | | or | | | | | |
| 65 | | COLUMN "G" (VERTEBRATE) OR COLUMN | | | | | $LC_{50}$ Data | LN of data | | $LC_{50}$ Data | LN of data | | | | |
| 66 | | "J" (INVERTEBRATE). THE 'CV' WILL BE | | | | | *********** | | | ************ | | | | | |
| 67 | | PICKED UP FOR THE CALCULATIONS | | | | 1 | 0 | | 1 | 4.7 | 1.547563 | | | | |
| 68 | | BELOW. THE DEFAULT VALUES FOR eA, | | | | 2 | | | 2 | 14.3 | 2.660260 | | | | |
| 69 | | eB, AND eC WILL CHANGE IF THE 'CV' IS | | | | 3 | | | 3 | 5 | 1.609438 | | | | |
| 70 | | ANYTHING OTHER THAN 0.6. | | | | 4 | | | 4 | 3 | 1.098612 | | | | |
| 71 | | | | | | 5 | | | 5 | 2.8 | 1.029619 | | | | |
| 72 | | | | | | 6 | | | 6 | 8.1 | 2.091864 | | | | |
| 73 | | | | | | 7 | | | 7 | 33.7 | 3.517498 | | | | |
| 74 | | Coefficient of Variation for effluent tests | | | | 8 | | | 8 | 6.4 | 1.856298 | | | | |
| 75 | | | | | | 9 | | | 9 | 100 | 4.605170 | | | | |
| 76 | | CV = | 2.92801801 | (Default 0.6) | | 10 | | | 10 | 100 | 4.605170 | | | | |
| 77 | | | | | | 11 | | | 11 | 100 | 4.605170 | | | | |
| 78 | | $\delta^2$ = | 2.25897687 | | | 12 | | | 12 | 100 | 4.605170 | | | | |
| 79 | | $\delta$ = | 1.50298931 | | | 13 | | | 13 | 100 | 4.605170 | | | | |
| 80 | | | | | | 14 | | | 14 | 100 | 4.605170 | | | | |
| 81 | | Using the log variance to develop eA | | | | 15 | | | 15 | 100 | 4.605170 | | | | |
| 82 | | | (P. 100, step 2a of TSD) | | | 16 | | | 16 | | | | | | |
| 83 | | Z = 1.881 (97% probability stat from table | | | | 17 | | | 17 | | | | | | |
| 84 | | A = | -1.6976345 | | | 18 | | | 18 | | | | | | |
| 85 | | eA = | 0.18311618 | | | 19 | | | 19 | | | | | | |
| 86 | | | | | | 20 | | | 20 | | | | | | |
| 87 | | Using the log variance to develop eB | | | | | | | | | | | | | |
| 88 | | | (P. 100, step 2b of TSD) | | | St Dev | NEED DATA | NEED DATA | St Dev | 47.176275 | 1.5029893 | | | | |
| 89 | | $\delta_4^2$ = | 1.14528032 | | | Mean | 0 | 0 | Mean | 51.866667 | 3.1764895 | | | | |
| 90 | | $\delta_4$ = | 1.0701777 | | | Variance | 0 | 0.000000 | Variance | 2225.601 | 2.258977 | | | | |
| 91 | | B = | -1.4403641 | | | CV | 0 | | CV | 2.928018 | | | | | |
| 92 | | eB = | 0.23684151 | | | | | | | | | | | | |
| 93 | | | | | | | | | | | | | | | |
| 94 | | Using the log variance to develop eC | | | | | | | | | | | | | |
| 95 | | | (P. 100, step 4a of TSD) | | | | | | | | | | | | |
| 96 | | | | | | | | | | | | | | | |
| 97 | | $\delta^2$ = | 2.25897687 | | | | | | | | | | | | |
| 98 | | $\delta$ = | 1.50298931 | | | | | | | | | | | | |
| 99 | | C = | 1.69763446 | | | | | | | | | | | | |
| 100 | | eC = | 5.46101385 | | | | | | | | | | | | |
| 101 | | | | | | | | | | | | | | | |
| 102 | | Using the log variance to develop eD | | | | | | | | | | | | | |
| 103 | | | (P. 100, step 4b of TSD) | | | | | | | | | | | | |
| 104 | | n = | 1 | This number will most likely stay as "1", for 1 sample/month. | | | | | | | | | | | |
| 105 | | $\delta_n^2$ = | 2.25897687 | | | | | | | | | | | | |
| 106 | | $\delta_n$ = | 1.50298931 | | | | | | | | | | | | |
| 107 | | D = | 1.69763446 | | | | | | | | | | | | |
| 108 | | eD = | 5.46101385 | | | | | | | | | | | | |
| 109 | | | | | | | | | | | | | | | |

## Page 3 - Follow directions to develop a site specific ACR (Acute to Chronic Ratio)

To determine Acute/Chronic Ratio (ACR), insert usable data below. Usable data is defined as valid paired test results, acute and chronic, tested at the same temperature, same species. The chronic NOEC must be less than the acute $LC_{50}$, since the ACR divides the $LC_{50}$ by the NOEC. $LC_{50}$'s >100% should not be used.

**Table 1. ACR using Vertebrate data**

| Set # | $LC_{50}$ | NOEC | Test ACR | Logarithm | Geomean | Antilog | ACR to Use |
|---|---|---|---|---|---|---|---|
| 1 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 2 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 3 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 4 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 5 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 6 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 7 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 8 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 9 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 10 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| | | | | ACR for vertebrate data: | | | 0 |

| | | |
|---|---|---|
| Table 1. Result: | Vertebrate ACR | 0 |
| Table 2. Result: | Invertebrate ACR | 0 |
| | Lowest ACR | Default to 10 |

**Table 2. ACR using Invertebrate data**

| Set # | $LC_{50}$ | NOEC | Test ACR | Logarithm | Geomean | Antilog | ACR to Use |
|---|---|---|---|---|---|---|---|
| 1 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 2 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 3 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 4 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 5 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 6 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 7 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 8 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 9 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| 10 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | NO DATA |
| | | | | ACR for vertebrate data: | | | 0 |

**Convert $LC_{50}$'s and NOEC's to Chronic TU's for use in WLA.EXE**

Table 3. ACR used: 10

| | Enter $LC_{50}$ | TUc | Enter NOEC | TUc |
|---|---|---|---|---|
| 1 | | NO DATA | | NO DATA |
| 2 | | NO DATA | | NO DATA |
| 3 | | NO DATA | | NO DATA |
| 4 | | NO DATA | | NO DATA |
| 5 | | NO DATA | | NO DATA |
| 6 | | NO DATA | | NO DATA |
| 7 | | NO DATA | | NO DATA |
| 8 | | NO DATA | | NO DATA |
| 9 | | NO DATA | | NO DATA |
| 10 | | NO DATA | | NO DATA |
| 11 | | NO DATA | | NO DATA |
| 12 | | NO DATA | | NO DATA |
| 13 | | NO DATA | | NO DATA |
| 14 | | NO DATA | | NO DATA |
| 15 | | NO DATA | | NO DATA |
| 16 | | NO DATA | | NO DATA |
| 17 | | NO DATA | | NO DATA |
| 18 | | NO DATA | | NO DATA |
| 19 | | NO DATA | | NO DATA |
| 20 | | NO DATA | | NO DATA |

If WLA.EXE determines that an acute limit is needed, you need to convert the TUc answer you get to TUa and then an LC50, enter it here:

| | |
|---|---|
| NO DATA | %$LC_{50}$ |
| NO DATA | TUa |

**DILUTION SERIES TO RECOMMEND**

**Table 4.**

| | Monitoring % Effluent | Monitoring TUc | Limit % Effluent | Limit TUc |
|---|---|---|---|---|
| Dilution series based on data mean | 3.1 | 32.634098 | | |
| Dilution series to use for limit | | | 2 | 50 |
| Dilution factor to recommend: | 0.1750508 | | 0.1414214 | |
| Dilution series to recommend: | 100.0 | 1.00 | 100.0 | 1.00 |
| | 17.5 | 5.71 | 14.1 | 7.07 |
| | 3.1 | 32.63 | 2.0 | 50.00 |
| | 0.5 | 186.43 | 0.3 | 353.55 |
| | 0.09 | 1064.98 | 0.0 | 2500.00 |
| Extra dilutions if needed | 0.02 | 6083.86 | 0.0 | 17677.67 |
| | 0.00 | 34754.80 | 0.0 | 125000.00 |

**Cell:** I9
**Comment:**

**Cell:** K18
**Comment:** This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

**Cell:** J22
**Comment:** Remember to change the "N" to "Y" if you have ratios entered, otherwise, they won't be used in the calculations.

**Cell:** C40
**Comment:**
If you have entered data to calculate an ACR on page 3, and this is still defaulted to "10", make sure you have selected "Y" in cell E21

**Cell:** C41
**Comment:** If you have entered data to calculate an effluent specific CV on page 2, and this is still defaulted to "0.6", make sure you have selected "Y" in cell E20

**Cell:** L48
**Comment:**
See Row 151 for the appropriate dilution series to use for these NOEC's

**Cell:** G62
**Comment:**
Vertebrates are:
Pimephales promelas
Oncorhynchus mykiss
Cyprinodon variegatus

**Cell:** J62
**Comment:**
Invertebrates are:
Ceriodaphnia dubia
Mysidopsis bahia

**Cell:** C117
**Comment:** Vertebrates are:

Pimephales promelas
Cyprinodon variegatus

**Cell:** M119
**Comment:** The ACR has been picked up from cell C34 on Page 1. If you have paired data to calculate an ACR, enter it in the tables to the left, and make sure you have a "Y" in cell E21 on Page 1. Otherwise, the default of 10 will be used to convert your acute data.

**Cell:** M121
**Comment:** If you are only concerned with acute data, you can enter it in the NOEC column for conversion and the number calculated will be equivalent to the TUa. The calculation is the same: 100/NOEC = TUc or 100/LC50 = TUa.

**Cell:** C138
**Comment:** Invertebrates are:

Ceriodaphnia dubia
Mysidopsis bahia

# 2004 Evaluation and Limitation Development

Facility = VaP-Chesterfield Outfall 004
Chemical = Chronic WET
Chronic averaging period = 4
WLAa = 162.889
WLAc = 54.296
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 16
Expected Value = 45.4784
Variance = 78606.1
C.V. = 6.164856
97th percentile daily values = 266.605
97th percentile 4 day average = 251.118
97th percentile 30 day average = 141.762
# < Q.L. = 0
Model used = lognormal

**A limit is needed based on Chronic Toxicity**
Maximum Daily Limit = 57.6444980410129
Average Weekly limit = 57.6444980410129
Average Monthly Limit = 57.6444980410129

The data are:

1
1
1
1
1
1
20
4
50
50
50
50
50
50
1
50

The chronic toxicity data for reproduction are entered above in chronic toxicity units ($TU_C$), which are calculated by dividing 100 by the NOEC. Example: For a NOEC of 100%, $TU_C$ equals 100 ÷ 100% = 1.

The permit limitation is derived as follows from the limit indicated above:

Calculate NOEC of indicated limit: 100 ÷ 57.64 = 1.74%, which is rounded to 2%.

Calculate $TU_C$ of NOEC of 2%: 100 ÷ 2% = 50 $TU_C$

# Spreadsheet for determination of WET test endpoints or WET limits

**Excel 97**
**Revision Date: 01/10/05**
**File: WETLIM10.xls**
**(MIX.EXE required also)**

| Acute Endpoint/Permit Limit | | | Use as $LC_{50}$ in Special Condition, as TUa on DMR | | | |
|---|---|---|---|---|---|---|
| ACUTE | 15.61987369 | TUa | $LC_{50}$ = | 7 | % Use as | 14.28 TUa |
| ACUTE WLAa | | 32.0391304 | Note: Inform the permittee that if the mean of the data exceeds this TUa: | 4.38876861 | a limit may result using WLA.EXE | |

| Chronic Endpoint/Permit Limit | | | Use as NOEC in Special Condition, as TUc on DMR | | | |
|---|---|---|---|---|---|---|
| CHRONIC | 156.1987369 | $TU_c$ | NOEC = | 1 | % Use as | 100.00 $TU_c$ |
| BOTH* | 320.3913122 | $TU_c$ | NOEC = | 1 | % Use as | 100.00 $TU_c$ |
| AML | 156.1987369 | $TU_c$ | NOEC = | 1 | % Use as | 100.00 $TU_c$ |
| ACUTE WLAa,c | | 320.391304 | Note: Inform the permittee that if the mean | | | |
| CHRONIC WLAc | | 106.797101 | of the data exceeds this TUc: | | | 64.1890385 |
| * Both means acute expressed as chronic | | | a limit may result using WLA.EXE | | | |

**Enter data in the cells with blue type:**

| | | |
|---|---|---|
| Entry Date: | 08/20/12 | |
| Facility Name: | Dominion Chesterfield Pow | |
| VPDES Number: | VA0004146 | |
| Outfall Number: | 005 | |
| Plant Flow: | 4.83 | MGD |
| Acute 1Q10: | 511 | MGD |
| Chronic 7Q10: | 511 | MGD |

| % Flow to be used from MIX.EXE | |
|---|---|
| 100 | % |
| 100 | % |

| Difuser /modeling study? | | |
|---|---|---|
| Enter Y/N | n | |
| Acute | 1 | :1 |
| Chronic | 49 | :1 |

| | | | |
|---|---|---|---|
| Are data available to calculate CV? (Y/N) | N | (Minimum of 10 data points, same species, needed) | Go to Page 2 |
| Are data available to calculate ACR? (Y/N) | N | (NOEC<LC50, do not use greater/less than data) | Go to Page 3 |

| | | | |
|---|---|---|---|
| $IWC_a$ | 0.936355001 | % | Plant flow/plant flow + 1Q10 |
| $IWC_c$ | 0.936355001 | % | Plant flow/plant flow + 7Q10 |

**NOTE: If the IWCa is >33%, specify the NOAEC = 100% test/endpoint for use**

| | | |
|---|---|---|
| Dilution, acute | 106.7971014 | 100/IWCa |
| Dilution, chronic | 106.7971014 | 100/IWCc |
| $WLA_a$ | 32.03913043 | Instream criterion (0.3 TUa) X's Dilution, acute |
| $WLA_c$ | 106.7971014 | Instream criterion (1.0 TUc) X's Dilution, chronic |
| $WLA_{a,c}$ | 320.3913043 | ACR X's $WLA_a$ - converts acute WLA to chronic units |
| ACR -acute/chronic ratio | 10 | LC50/NOEC (Default is 10 - if data are available, use tables Page 3) |
| CV-Coefficient of variatior | 0.6 | Default of 0.6 - if data are available, use tables Page 2) |
| Constants eA | 0.4109447 | Default = 0.41 |
| eB | 0.6010373 | Default = 0.60 |
| eC | 2.4334175 | Default = 2.43 |
| eD | 2.4334175 | Default = 2.43 (1 samp) No. of samples 1 |

**The Maximum Daily Limit is calculated from the lowest LTA, X's eC. The LTAa,c and MDL using it are driven by the ACR.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $LTA_{a,c}$ | 131.6631084 | WLAa,c X's eA | | | | | | |
| $LTA_c$ | 64.1890415 | WLAc X's eB | | | | Rounded NOEC's | | % |
| MDL** with $LTA_{a,c}$ | 320.3913122 | $TU_c$ | NOEC = | 0.312118 | (Protects from acute/chronic toxicity) | NOEC = | 1 | % |
| MDL** with $LTA_c$ | 156.1987369 | $TU_c$ | NOEC = | 0.640210 | (Protects from chronic toxicity) | NOEC = | 1 | % |
| AML with lowest LTA | 156.1987369 | $TU_c$ | NOEC = | 0.640210 | Lowest LTA X's eD | NOEC = | 1 | |

IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM $TU_c$ to $TU_a$

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Rounded LC50's | | % |
| MDL with $LTA_{a,c}$ | 32.03913122 | $TU_a$ | LC50 = | 3.121183 | % | LC50 = | 4 | % |
| MDL with $LTA_c$ | 15.61987369 | $TU_a$ | LC50 = | 6.402100 | % | LC50 = | 7 | |

## Page 2 - Follow the directions to develop a site specific CV (coefficient of variation)

| B | C | D | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|
| IF YOU HAVE AT LEAST 10 DATA POINTS THAT | | | | Vertebrate | | | Invertebrate | |
| ARE QUANTIFIABLE (NOT "<" OR ">") | | | | $IC_{25}$ Data | | | $IC_{25}$ Data | |
| FOR A SPECIES, ENTER THE DATA IN EITHER | | | | or | | | or | |
| COLUMN "G" (VERTEBRATE) OR COLUMN | | | | $LC_{50}$ Data | LN of data | | $LC_{50}$ Data | LN of data |
| "J" (INVERTEBRATE). THE 'CV' WILL BE | | | | *********** | | | ************ | |
| PICKED UP FOR THE CALCULATIONS | | | 1 | 0 | | 1 | 0 | |
| BELOW. THE DEFAULT VALUES FOR eA, | | | 2 | | | 2 | | |
| eB, AND eC WILL CHANGE IF THE 'CV' IS | | | 3 | | | 3 | | |
| ANYTHING OTHER THAN 0.6. | | | 4 | | | 4 | | |
| | | | 5 | | | 5 | | |
| | | | 6 | | | 6 | | |
| | | | 7 | | | 7 | | |
| Coefficient of Variation for effluent tests | | | 8 | | | 8 | | |
| | | | 9 | | | 9 | | |
| CV = | 0.6 | (Default 0.6) | 10 | | | 10 | | |
| | | | 11 | | | 11 | | |
| $\delta^2$ = | 0.3074847 | | 12 | | | 12 | | |
| $\delta$ = | 0.554513029 | | 13 | | | 13 | | |
| | | | 14 | | | 14 | | |
| Using the log variance to develop eA | | | 15 | | | 15 | | |
| | (P. 100, step 2a of TSD) | | 16 | | | 16 | | |
| Z = 1.881 (97% probability stat from table | | | 17 | | | 17 | | |
| A = | -0.88929666 | | 18 | | | 18 | | |
| eA = | 0.410944686 | | 19 | | | 19 | | |
| | | | 20 | | | 20 | | |
| Using the log variance to develop eB | | | | | | | | |
| | (P. 100, step 2b of TSD) | | St Dev | NEED DATA | NEED DATA | St Dev | NEED DATA | NEED DATA |
| $\delta_4^2$ = | 0.086177696 | | Mean | 0 | 0 | Mean | 0 | 0 |
| $\delta_4$ = | 0.293560379 | | Variance | 0 | 0.000000 | Variance | 0 | 0.000000 |
| B = | -0.50909823 | | CV | 0 | | CV | 0 | |
| eB = | 0.601037335 | | | | | | | |
| | | | | | | | | |
| Using the log variance to develop eC | | | | | | | | |
| | (P. 100, step 4a of TSD) | | | | | | | |
| | | | | | | | | |
| $\delta^2$ = | 0.3074847 | | | | | | | |
| $\delta$ = | 0.554513029 | | | | | | | |
| C = | 0.889296658 | | | | | | | |
| eC = | 2.433417525 | | | | | | | |
| | | | | | | | | |
| Using the log variance to develop eD | | | | | | | | |
| | (P. 100, step 4b of TSD) | | | | | | | |
| n = | 1 | This number will most likely stay as "1", for 1 sample/month. | | | | | | |
| $\delta_n^2$ = | 0.3074847 | | | | | | | |
| $\delta_n$ = | 0.554513029 | | | | | | | |
| D = | 0.889296658 | | | | | | | |
| eD = | 2.433417525 | | | | | | | |

## Page 3 - Follow directions to develop a site specific ACR (Acute to Chronic Ratio)

To determine Acute/Chronic Ratio (ACR), insert usable data below. Usable data is defined as valid paired test results, acute and chronic, tested at the same temperature, same species. The chronic NOEC must be less than the acute $LC_{50}$, since the ACR divides the $LC_{50}$ by the NOEC. $LC_{50}$'s >100% should not be used.

**Table 1. ACR using Vertebrate data**

| Set # | $LC_{50}$ | NOEC | Test ACR | Logarithm | Geomean | Antilog | ACR to Use |
|---|---|---|---|---|---|---|---|
| 1 | 100 | 2 | 50 | 3.912023 | 3.912023005 | 50 | 0 |
| 2 | 100 | 2 | 50 | 3.912023 | 3.912023005 | 50 | 0 |
| 3 | 100 | 2 | 50 | 3.912023 | 3.912023005 | 50 | 0 |
| 4 | 100 | 2 | 50 | 3.912023 | 3.912023005 | 50 | 0 |
| 5 | 88 | 100 | 0.88 | -0.127833 | #NUM! | #NUM! | 0 |
| 6 | 100 | 2 | 50 | 3.912023 | #NUM! | #NUM! | 0 |
| 7 | 37 | 4 | 9.25 | 2.2246236 | #NUM! | #NUM! | 0 |
| 8 | 37 | 32 | 1.15625 | 0.145182 | #NUM! | #NUM! | 0 |
| 9 | 100 | 100 | 1 | 0 | #NUM! | #NUM! | 0 |
| 10 | 100 | 32 | 3.125 | 1.1394343 | #NUM! | #NUM! | 0 |
| | | | | ACR for vertebrate data: | | | 0 |

| | | |
|---|---|---|
| Table 1. Result: | Vertebrate ACR | 0 |
| Table 2. Result: | Invertebrate ACR | 0 |
| | Lowest ACR | Default to 10 |

**Table 2. ACR using Invertebrate data**

| Set # | $LC_{50}$ | NOEC | Test ACR | Logarithm | Geomean | Antilog | ACR to Use |
|---|---|---|---|---|---|---|---|
| 1 | 100 | 2 | 50 | 3.912023 | 3.912023005 | 50 | 0 |
| 2 | 100 | 2 | 50 | 3.912023 | 3.912023005 | 50 | 0 |
| 3 | 100 | 2 | 50 | 3.912023 | 3.912023005 | 50 | 0 |
| 4 | 100 | 2 | 50 | 3.912023 | 3.912023005 | 50 | 0 |
| 5 | 88 | 100 | 0.88 | -0.127833 | #NUM! | #NUM! | 0 |
| 6 | 100 | 2 | 50 | 3.912023 | #NUM! | #NUM! | 0 |
| 7 | 37 | 4 | 9.25 | 2.2246236 | #NUM! | #NUM! | 0 |
| 8 | 37 | 32 | 1.15625 | 0.145182 | #NUM! | #NUM! | 0 |
| 9 | 100 | 100 | 1 | 0 | #NUM! | #NUM! | 0 |
| 10 | 100 | 32 | 3.125 | 1.1394343 | #NUM! | #NUM! | 0 |
| | | | | ACR for vertebrate data: | | | 0 |

**Convert $LC_{50}$'s and NOEC's to Chronic TU's**
**for use in WLA.EXE**

**Table 3.** **ACR used: 10**

| | Enter $LC_{50}$ | TUc | Enter NOEC | TUc |
|---|---|---|---|---|
| 1 | >37 | #DIV/0! | 4 | 25.000000 |
| 2 | >37 | #DIV/0! | 32 | 3.125000 |
| 3 | >100 | #DIV/0! | 100 | 1.000000 |
| 4 | >100 | #DIV/0! | 32 | 3.125000 |
| 5 | | NO DATA | | NO DATA |
| 6 | | NO DATA | | NO DATA |
| 7 | | NO DATA | | NO DATA |
| 8 | | NO DATA | | NO DATA |
| 9 | | NO DATA | | NO DATA |
| 10 | | NO DATA | | NO DATA |
| 11 | | NO DATA | | NO DATA |
| 12 | | NO DATA | | NO DATA |
| 13 | | NO DATA | | NO DATA |
| 14 | | NO DATA | | NO DATA |
| 15 | | NO DATA | | NO DATA |
| 16 | | NO DATA | | NO DATA |
| 17 | | NO DATA | | NO DATA |
| 18 | | NO DATA | | NO DATA |
| 19 | | NO DATA | | NO DATA |
| 20 | | NO DATA | | NO DATA |

If WLA.EXE determines that an acute limit is needed, you need to convert the TUc answer you get to TUa and then an LC50, enter it here: NO DATA $\%LC_{50}$
NO DATA TUa

**DILUTION SERIES TO RECOMMEND**

**Table 4.**

| | Monitoring % Effluent | Monitoring TUc | Limit % Effluent | Limit TUc |
|---|---|---|---|---|
| Dilution series based on data mean | 1.6 | 64.18904 | | |
| Dilution series to use for limit | | | 1 | 100 |
| Dilution factor to recommend: | 0.1248158 | | 0.1 | |
| Dilution series to recommend: | 100.0 | 1.00 | 100.0 | 1.00 |
| | 12.5 | 8.01 | 10.0 | 10.00 |
| | 1.6 | 64.19 | 1.0 | 100.00 |
| | 0.2 | 514.27 | 0.1 | 1000.00 |
| | 0.02 | 4120.23 | 0.0 | 10000.00 |
| Extra dilutions if needed | 0.00 | 33010.51 | 0.0 | 100000.00 |
| | 0.00 | 264473.77 | 0.0 | ######### |

**Cell:** I9
**Comment:**
This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

**Cell:** K18
**Comment:** This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

**Cell:** J22
**Comment:** Remember to change the "N" to "Y" if you have ratios entered, otherwise, they won't be used in the calculations.

**Cell:** C40
**Comment:**
If you have entered data to calculate an ACR on page 3, and this is still defaulted to "10", make sure you have selected "Y" in cell E21

**Cell:** C41
**Comment:** If you have entered data to calculate an effluent specific CV on page 2, and this is still defaulted to "0.6", make sure you have selected "Y" in cell E20

**Cell:** L48
**Comment:**
See Row 151 for the appropriate dilution series to use for these NOEC's

**Cell:** G62
**Comment:**
Vertebrates are:
Pimephales promelas
Oncorhynchus mykiss
Cyprinodon variegatus

**Cell:** J62
**Comment:**
Invertebrates are:
Ceriodaphnia dubia
Mysidopsis bahia

**Cell:** C117
**Comment:** Vertebrates are:

Pimephales promelas
Cyprinodon variegatus

**Cell:** M119
**Comment:** The ACR has been picked up from cell C34 on Page 1. If you have paired data to calculate an ACR, enter it in the tables to the left, and make sure you have a "Y" in cell E21 on Page 1. Otherwise, the default of 10 will be used to convert your acute data.

**Cell:** M121
**Comment:** If you are only concerned with acute data, you can enter it in the NOEC column for conversion and the number calculated will be equivalent to the TUa. The calculation is the same: 100/NOEC = TUc or 100/LC50 = TUa.

**Cell:** C138
**Comment:** Invertebrates are:

Ceriodaphnia dubia
Mysidopsis bahia

**Attachment 10**

NPDES Permit Rating Work Sheet

## NPDES PERMIT RATING WORK SHEET

☐ Regular Addition
☐ Discretionary Addition
☐ Score change, but no status change
☐ Deletion

NPDES NO. VA0004146

Facility Name: Dominion Chesterfield Power Station

City: Chesterfield County

Receiving Water: James River/Farrar Gut

Reach Number: ______

| | |
|---|---|
| *Is this facility a steam electric power plant (SIC=4911) with one or more of the following characteristics?*<br>1. Power output 500 MW or greater (not using a cooling pond/lake)<br>2. A nuclear power plant<br>3. Cooling water discharge greater than 25% of the receiving stream's 7Q10 flow rate<br>☒ YES; score is 600 (stop here) ☐ NO (continue) | *Is this permit for a municipal separate storm sewer serving a population greater than 100,000?*<br>☐ YES; score is 700 (stop here)<br>☐ NO (continue) |

## FACTOR 1: Toxic Pollutant Potential

PCS SIC Code: ______ Primary SIC Code: ______ Other SIC Codes: ______
Industrial Subcategory Code: ______ (Code 000 if no subcategory)

*Determine the Toxicity potential from Appendix A. Be sure to use the TOTAL toxicity potential column and check one)*

| Toxicity Group | Code | Points | Toxicity Group | Code | Points | Toxicity Group | Code | Points |
|---|---|---|---|---|---|---|---|---|
| ☐ No process waste streams | 0 | 0 | ☐ 3. | 3 | 15 | ☐ 7. | 7 | 35 |
| ☐ 1. | 1 | 5 | ☐ 4. | 4 | 20 | ☐ 8. | 8 | 40 |
| ☐ 2. | 2 | 10 | ☐ 5. | 5 | 25 | ☐ 9. | 9 | 45 |
| | | | ☐ 6. | 6 | 30 | ☐ 10. | 10 | 50 |

Code Number Checked: _____

**Total Points Factor 1**: _____

**FACTOR 2: Flow/Stream Flow Volume** (*Complete either Section A or Section B; check only one)*

Section A ? Wastewater Flow Only Considered

| Wastewater Type (See Instructions) | | Code | Points |
|---|---|---|---|
| Type I: Flow < 5 MGD | ☐ | 11 | 0 |
| Flow 5 to 10 MGD | ☐ | 12 | 10 |
| Flow > 10 to 50 MGD | ☐ | 13 | 20 |
| Flow > 50 MGD | ☐ | 14 | 30 |
| Type II: Flow < 1 MGD | ☐ | 21 | 10 |
| Flow 1 to 5 MGD | ☐ | 22 | 20 |
| Flow > 5 to 10 MGD | ☐ | 23 | 30 |
| Flow > 10 MGD | ☐ | 24 | 50 |
| Type III: Flow < 1 MGD | ☐ | 31 | 0 |
| Flow 1 to 5 MGD | ☐ | 32 | 10 |
| Flow > 5 to 10 MGD | ☐ | 33 | 20 |
| Flow > 10 MGD | ☐ | 34 | 30 |

Section B ? Wastewater and Stream Flow Considered

| Wastewater Type (See Instructions) | Percent of instream Wastewater Concentration at Receiving Stream Low Flow | | Code | Points |
|---|---|---|---|---|
| Type I/III: | < 10 % | ☐ | 41 | 0 |
| | 10 % to < 50 % | ☐ | 42 | 10 |
| | > 50 % | ☐ | 43 | 20 |
| Type II: | < 10 % | ☐ | 51 | 0 |
| | 10 % to <50 % | ☐ | 52 | 20 |
| | > 50 % | ☐ | 53 | 30 |

Code Checked from Section A or B: _____
**Total Points Factor 2:** _____

## FACTOR 3: Conventional Pollutants

*(only when limited by the permit)*

A. Oxygen Demanding Pollutant: (check one) ☐ BOD ☐ COD ☐ Other:____________________

Permit Limits: (check one)

| | | Code | Points |
|---|---|---|---|
| ☐ | < 100 lbs/day | 1 | 0 |
| ☐ | 100 to 1000 lbs/day | 2 | 5 |
| ☐ | > 1000 to 3000 lbs/day | 3 | 15 |
| ☐ | > 3000 lbs/day | 4 | 20 |

Code Checked: ___

**Points Scored**:_____

B. Total Suspended Solids (TSS)

Permit Limits: (check one)

| | | Code | Points |
|---|---|---|---|
| ☐ | < 100 lbs/day | 1 | 0 |
| ☐ | 100 to 1000 lbs/day | 2 | 5 |
| ☐ | > 1000 to 5000 lbs/day | 3 | 15 |
| ☐ | > 5000 lbs/day | 4 | 20 |

Code Checked: _____

**Points Scored**: _____

C. Nitrogen Pollutant: (check one) ☐ Ammonia ☐ Other: ____________________

Permit Limits: (check one)

| | *Nitrogen Equivalent* | *Code* | *Points* |
|---|---|---|---|
| ☐ | < 300 lbs/day | 1 | 0 |
| ☐ | 300 to 1000 lbs/day | 2 | 5 |
| ☐ | > 1000 to 3000 lbs/day | 3 | 15 |
| ☐ | > 3000 lbs/day | 4 | 20 |

Code Checked: _____

**Points Scored**:_____

**Total Points Factor 3**: _____

## FACTOR 4: Public Health Impact

*Is there a public drinking water supply located within 50 miles downstream of the effluent discharge (this includes any body of water to which the receiving water is a tributary)? A public drinking water supply may include infiltration galleries, or other methods of conveyance that ultimately get water from the above referenced supply.*

☐ YES (If yes, check toxicity potential number below)

☐ NO (If no, go to Factor 5)

Determine the *human health* toxicity potential from Appendix A. Use the same SIC code and subcategory reference as in Factor 1. (Be sure to use the human health toxicity group column ? check one below)

| Toxicity Group | Code | Points | Toxicity Group | Code | Points | Toxicity Group | Code | Points |
|---|---|---|---|---|---|---|---|---|
| ☐ No process waste streams | 0 | 0 | ☐ 3. | 3 | 0 | ☐ 7. | 7 | 15 |
| ☐ 1. | 1 | 0 | ☐ 4. | 4 | 0 | ☐ 8. | 8 | 20 |
| ☐ 2. | 2 | 0 | ☐ 5. | 5 | 5 | ☐ 9. | 9 | 25 |
| | | | ☐ 6. | 6 | 10 | ☐ 10. | 10 | 30 |

Code Number Checked: _____

**Total Points Factor 4**:_____

## FACTOR 5: Water Quality Factors

A. *Is (or will) one or more of the effluent discharge limits based on water quality factors of the receiving stream (rather than technology-based federal effluent guidelines, or technology-based state effluent guidelines), or has a wasteload allocation been assigned to the discharge:*

| | | Code | Points |
|---|---|---|---|
| ☐ | Yes | 1 | 10 |
| ☐ | No | 2 | 0 |

B. *Is the receiving water in compliance with applicable water quality standards for pollutants that are water quality limited in the permit?*

| | | Code | Points |
|---|---|---|---|
| ☐ | Yes | 1 | 0 |
| ☐ | No | 2 | 5 |

C. *Does the effluent discharged from this facility exhibit the reasonable potential to violate water quality standards due to wh ole effluent toxicity?*

| | | Code | Points |
|---|---|---|---|
| ☐ | Yes | 1 | 10 |
| ☐ | No | 2 | 0 |

Code Number Checked: A __ B __ C __

**Points Factor 5**: A __ + B __ + C __ = ___ TOTAL

## FACTOR 6: Proximity to Near Coastal Waters

A. *Base Score: Enter flow code here (from Factor 2):___*

*Enter the multiplication factor that corresponds to the flow code: ___*

Check appropriate facility HPRI Code (from PCS):

| | *HPRI#* | *Code* | *HPRI Score* |
|---|---|---|---|
| ☐ | 1 | 1 | 20 |
| ☐ | 2 | 2 | 0 |
| ☐ | 3 | 3 | 30 |
| ☐ | 4 | 4 | 0 |
| ☐ | 5 | 5 | 20 |

| *Flow Code* | *Multiplication Factor* |
|---|---|
| 11, 31, or 41 | 0.00 |
| 12, 32, or 42 | 0.05 |
| 13, 33, or 43 | 0.10 |
| 14 or 34 | 0.15 |
| 21 or 51 | 0.10 |
| 22 or 52 | 0.30 |
| 23 or 53 | 0.60 |
| 24 | 1.00 |

HPRI code checked: ___

Base Score: (HPRI Score) ____ X (Multiplication Factor) ____ = ____ (TOTAL POINTS)

B. *Additional Points* ☐ *NEP Program*
*For a facility that has an HPRI code of 3, does the facility discharge to one of the estuaries enrolled in the National Estuary Protection (NEP) program (see instructions) or the Chesapeake Bay?*

| | | Code | Points |
|---|---|---|---|
| ☐ | Yes | 1 | 10 |
| ☐ | No | 2 | 0 |

C. *Additional Points* ☐ *Great Lakes Area of Concern*
*For a facility that has an HPRI code of 5, does the facility discharge any of the pollutants of concern into one of the Great Lakes' 31 areas of concern (see Instructions)*

| | | Code | Points |
|---|---|---|---|
| ☐ | Yes | 1 | 10 |
| ☐ | No | 2 | 0 |

Code Number Checked: A __ B __ C __

**Points Factor 6**: A ___ + B ___ + C ___ = ___ TOTAL

**NPDES No.: VA0004146**

## SCORE SUMMARY

| Factor | Description | Total Points |
|---|---|---|
| 1 | Toxic Pollutant Potential | ____ |
| 2 | Flows/Streamflow Volume | ____ |
| 3 | Conventional Pollutants | ____ |
| 4 | Public Health Impacts | ____ |
| 5 | Water Quality Factors | ____ |
| 6 | Proximity to Near Coastal Waters | ____ |
| | TOTAL (Factors 1 through 6) | ____ |

S1. Is the total score equal to or greater than 80? ☒ Yes (Facility is a major) ☐ No

S2. If the answer to the above questions is no, would you like this facility to be discretionary major?

☐ No

☐ Yes (Add 500 points to the above score and provide reason below:

Reason:

NEW SCORE: ______

OLD SCORE: ______

Emilee C. Adamson
Permit Reviewer's Name

(804) 527-5072
Phone Number

__8.24.12___________
Date

**Attachment** 11

Site Visit Memo

**MEMORANDUM**

**DEPARTMENT OF ENVIRONMENTAL QUALITY**
***Piedmont Regional Office***

**4949-A Cox Road** **Glen Allen, VA 23060** **804/527-5020**

**SUBJECT**: Dominion Virginia Power – Chesterfield Power Station
Site Visit Report

**DATE**: December 21, 2009

Ray Jenkins, Tamira Cohen and I performed an announced site visit on December 16, 2009 at Dominion's Chesterfield Power Station. The Dominion representatives present were Dawn Garber, Ken Roller, Rick Woolard, Amelia Boschen, and Carissa Agnese.

We planned the site visit to incorporate both the VPDES IP and the Industrial Storm Water GP. This memo will focus on the IP aspects of the facility as the ISWGP is handled separately by Tamira Cohen.

The Chesterfield Power Station generates electricity using steam produced by the combustion of coal, natural gas and fuel oil. The Station has a generating capacity of 1750 megawatts (maximum dependable capacity of 1631 megawatts in the summer and 1731 megawatts in the winter).

Outfalls 001, 002 and 003 are all non-contact cooling water discharges of 211 MGD, 89 MGD and 757 MGD (maximums), respectively. Outfalls 001 and 002 discharge to the main stem of the James River. Outfall 003 discharges to the head of Farrar Gut. Outfall 001 discharges cooling water from Units 7 and 8, which are combined cycle gas turbines. Outfall 002 discharges cooling water from Unit 3, and Outfall 003 discharges cooling water from Units 4, 5, and 6. Units 3 through 6 are pulverized coal boilers, and represent the majority of electricity generation.

Outfall 004 is the discharge from the old ash pond to the head of Farrar Gut. Process wastewater throughout the station (including WTP effluent, FGD WWTP effluent, boiler blowdown, etc) is routed through the master sump and ultimately discharges to the old ash pond. Wet fly ash is sluiced directly to the old ash pond and pretreated wastewater from the metals pond is discharged directly to the old ash pond. Several of the influent waste streams are pretreated individually. The master sump initially discharges to the master sump pond, which provides for settling and O&G removal through a series of booms. The master sump pond discharges to the old ash pond.

Outfall 005 is the discharge from the new ash pond or Upper (East) Ash Pond to Farrar Gut at a point approximately 0.4 mile upstream from Farrar Gut's confluence with the James River. The new ash pond is currently used to dispose of dewatered ash from the old ash pond. The use of the new pond is addressed in the "Revised Closure Plan, Upper (East) Ash Pond, Chesterfield Power Station, Chesterfield County, Virginia" dated September 2003 and approved by the staff of the DEQ by letter dated September 12, 2003. The discharge at Outfall 005 consists of runoff from the disposed ash after treatment in a large sedimentation pond that was constructed at the eastern end of the pond. This pond typically discharges only 2 -3 months out of the year for less than 4 consecutive days.

The site visit involved a general overview of the industrial process and a more in depth review of the installed air and water pollution control technology. The industrial activity as described above is primarily related to coal fired power generation. Coal is transported in on rail and stored in delineated piles according to sulfur content. Storm water drainage from the coal pile is directed to the old ash pond, and subsequently discharged through Outfall 004. Number 2 fuel oil for the combined cycle turbines is delivered by barge and stored in an 11 million gallon above ground storage tank with secondary containment. Above ground petroleum storage tanks are managed by the LUST/AST program.

Burning coal generates air pollutants (primarily NOx and $SO_2$) and ash (bottom ash and fly ash), both of which are managed in an effort to protect the environment. Bottom ash is collected from the bottom of the boilers and either reused in aggregates or land-filled. Fly ash is entrained in the flue gas and collected primarily through vacuum bags, which capture the vast majority of fly ash. Additional fly ash is inadvertently captured during the SCR process. After collection, wet ash is sluiced to the old ash pond, where sedimentation occurs. The wet ash is actively dredged from the inlet channel to the old ash pond, allowed to dewater, and then trucked to the new ash pond for disposal.

NOx and $SO_2$ are addressed by installed treatment systems: selective catalytic reduction (SCR) and Flue Gas Desulfurization (FGD). The SCR is a means of converting nitrogen oxides (NOx) with the aid of a catalyst and reductant (aqueous ammonia) into diatomic nitrogen and water. Aqueous ammonia is injected into flue gas, before the gas passes through the catalyst chamber where 70-95% of the NOx is converted. An unintended byproduct of this process is additional fly ash capture from the flue gas. The ash from the SCR is directed to the old ash pond.

The FGD system (currently operating for Unit 6) removes sulfur dioxide by injecting lime slurry into flue gas. Calcium carbonate reacts with sulfur dioxide to form calcium sulfite (gypsum) and carbon dioxide. Lime is delivered to the site via barge, transported by conveyer and stored under cover. Limestone is pulverized in a ball mill and blended with treated effluent from Proctor's Creek WWTP to create a lime slurry. The slurry is then injected into the absorber with a constant recycle that generates a continuous slurry shower. Efficiency of Sulfur dioxide removal is compromised as the density of the slurry increases. So, at a prescribed density range, the slurry is wasted to hydroclones that dewater the slurry to 50% water content. Further dewatering is achieved with the vacuum filter drying belt, which reduces the water content to below 10%. The resultant solid is gypsum that can be sold for beneficial use. Gypsum is stored under cover and transported to the customer (currently USG) by barge. The wastewater that is drawn off at each stage is captured and recycled back as make-up water for the lime slurry. Gypsum quality is affected by chloride concentration; therefore, at high chloride concentrations the wastewater goes through a secondary hydroclone to purge chloride saturated water and still recycle the cleaner water back as make-up. FGD units are expected to achieve approximately 97% reduction in sulfur dioxide emissions, and they generate nearly twice as much gypsum as the lime that feeds the process. Chesterfield's FGD treatment system is a state of the art and highly automated process. The process is closely monitored via computer integrated remote sensing and manual sampling to keep it in operation. Chesterfield will not bypass the FGD system. Consequently, FGD operation is critical to keeping the power generating units online, and the system is managed accordingly.

The FGD waste stream is purged to the FGD wastewater treatment plant where the wastewater is pretreated before being discharged to the master sump, which discharges to the master sump pond, then to the old ash pond and ultimately Outfall 004. The wastewater treatment is a batched process based on FGD operation. The wastewater plant is currently operating at approximately 12 hour intervals. The treatment plant consists of wastewater equalization, pH elevation, gypsum desaturation, heavy metal precipitation, coagulation, flocculation, clarification, ph adjustment, and sludge dewatering. Dewatered sludge is land-filled or beneficially used in aggregates. The wastewater treatment is achieved through chemical addition. All chemicals are accounted for on the VPDES Reissuance application and appeared to be stored under cover and with secondary containment where necessary.

Boiler water must be exceptionally clean to protect the turbines and maintain efficiency; consequently, county water is treated onsite through filtration, reverse osmosis, and demineralization. Wastewater from the water treatment plant is directed to the old ash pond. The purified water is then used in the boilers to generate the steam that turns the turbines. Thereafter, the steam is run through condensers that use non contact cooling water, where the steam condenses and is recycled back through the boiler. The cooling water used in the condenser is drawn from the James River through 6 intakes. Each cooling water intake is equipped with a bar screen to remove debris and a travelling screen to remove smaller material (including entrained fish). The travelling screen is continually backwashed with untreated river water. These backwashes are discharged directly to the river (Outfalls 006 through 011 in the 2004 permit). Sodium hypochlorite is injected as a biocide in the cooling water before it enters the condenser. An intensive re-plumbing project was undertaken during the 2004 permit cycle in order to relocate the chlorine injection points downstream of where screen backwash water is pulled off of the cooling water headers. During the site visit, we observed several of the relocated injection points. In recent months, the facility has been adding sawdust to the intake for Unit 5 in order to plug minor leaks in the condenser tubing for that Unit. Bob Booterbaugh met us at the sawdust addition location to explain the process and answer any questions. The sawdust method is a standard procedure used to address minor pinhole leaks. Staff is planning condenser maintenance and re-tubing in 2011.

On the day of our visit, the Power Station was operating at full capacity with all six boilers on line. The site is under an ongoing construction project to build a second FGD system to service Units 3, 4, and 5. The projected completion date is in 2011. Construction aside, the station appeared to be operating as normal. Standard housekeeping was well-attended, especially given the active construction. The visit included the following: a brief walk through the power station and master sump area, barge area, water intakes (screen backwashes), reuse intake (screen backwash), sawdust addition procedure, SCR process, FGD process, FGD wastewater treatment system, metals treatment pond, upper and lower ash ponds, ground water monitoring well locations, recovery wells and toe drains for the new ash pond, process water outfalls (001-005) and SW outfalls (001-008, 009-017). No obvious stream impacts were observed at any of the outfalls. Ash pond management seemed to be progressing in accordance with the closure plan for the new pond. The facility appears to be in compliance with its VPDES individual permit and the staff has no recommendations at this time.

/ecc